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RESEARCH PROGRAM ABSTRACTS

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Ontario

Ministry
of the
Environment

The Honourable
Jim Bradley
Minister

Rod McLeod
Deputy Minister

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MINISTRY OF THE ENVIRONMENT

ONTARIO

RESEARCH PROGRAM ABSTRACTS

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Hon. Jim Bradley
Minister

Rod McLeod
Deputy Minister

Goal Statement

"To achieve and maintain a quality of the environment - including air, water and land - that will protect human health and the ecosystem and will contribute to the well-being of the people of Ontario."

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DISCLAIMER

The views and ideas expressed in these abstracts are those of the authors and do not necessarily reflect the views and policies of the Ministry of the Environment, nor does mention of trade names or commercial products constitute endorsement or recommendation for use.

INTRODUCTION

The Ontario Ministry of the Environment's Scientific Research Program has met with considerable success since the consolidation of its co-ordination and management. The implementation of the Research Planning Process has provided a focus for Ministry-wide research planning and has enabled Ministry Branches and Regions to identify their research needs and priorities. The Ministry publication, "Scientific Research Needs", published in 1984 and revised in 1986, provided a useful guide to university researchers and private consultants in their search for funding support of proposals dealing with air, water, liquid and solid waste, analytical methods and lately, environmental economics. This has resulted in a large number of ongoing projects dealing with the total environment.

This report provides a collection of abstracts of ongoing Ministry research projects, including those presented at the 1986 Technology Transfer Conference. The abstracts are grouped into five sections corresponding to the five major research areas.

The 1986 Technology Transfer Conference Proceedings, ISSN 0825-4591, published by the Ministry, provide detailed progress reports on many of the abstracts presented in this report.

For further details, the reader is referred to the principal investigator(s) or to the Research Management Office, Policy & Planning Branch, 135 St. Clair Avenue West, Toronto, Ontario, Canada, M4V 1P5; phone (416) 323-4573.

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AIR QUALITY RESEARCH

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Project No.: 177PL Liaison Officer : V. Ozvacic Phone: 965-5776

KEY WORDS: Refuse, Incineration, Flyash, Stack Gas, Dioxins, Furans, GC-MS.

Title: The Rapid Screening of Municipal Refuse Incinerator Fly-Ash and Stack Gas for PCDD/PCDF Using a Transportable Tandem Mass Spectrometer (GC/MS/MS) System.

Abstract:

The formation of polychlorinated dibenzo-p-dioxins and dibenzofurans (PCDD/PCDF) is linked to combustion processes. To date, there has been no conclusive study on the correlation of PCDD/PCDF formation with combustion conditions. One of the limitations is the lack of efficient, fast and economic analytical procedures. This paper describes a rapid analytical approach using gas chromatography (GC) coupled to tandem triple quadrupole mass spectrometry (MS/MS). This combination has been demonstrated to be more specific conventional GC/MS while requiring less time per analysis. Furthermore, the instrument used in the present work (The TAGA 6000E manufactured by SCIEX) is fully transportable, permitting it to be driven to the incinerator for rapid on-site PCDD/PCDF analysis. The analysis of fly-ash and stack gas will be described and analytical results compared to GC/MS analyses performed on the same samples.

ABSTRACT FORM

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Project No.: 101RR Liaison Officer : W. Chan Phone: 965-4081

KEY WORDS: Air Pollution, Correlation spectroscopy, Emission Montoring.

Title: Retrospective Correlation Spectroscopy and its Application to Atmospheric Monitoring.

Abstract:

Correlation spectroscopy is a diagnostic procedure for determination of column densities of absorbers by quantitative correlative comparison between the spectral signatures of a field spectrum and the intrinsic spectral features of such molecular species of interest as oxides of sulphur and nitrogen. Dispersive and non-dispersive correlation methods have been developed. In the past, analogue applications of these methods have been developed. In this paper a review is given of newly developed digital methods of dispersive and non-dispersive correlation spectroscopy.

In retrospective correlation spectroscopy the traditional oscillating focal plane mask, which is the mechanical analogue of the molecular species spectrum, is replaced by a numerical digitally synthesised mask for each species of interest. Correlations between the digitally recorded field spectrum and each mask are retrospectively evaluated digitally. From a theoretical assessment of the method in optically thin cases, it is easy to show that

$$C(z) = A - NX\,E(z)$$

where $C(z)$ is the correlation integral between the field spectrum and mask function when out of register by an amount z, A is the mask area, and $E(z)$ is the convolution of the mask function with the absorption cross-section function of the spectral feature in question. $C(z)$ and $E(z)$ can be numerically evaluated for each of a range of values of z. This equation provides a direct diagnostic method of evaluating the column density NX of the species over a path X for a concentration N from the slope of a plot of $C(z)$ vs. $E(z)$. This method has been tested by using digitally recorded sulphur dioxide spectral features and a variety of mask and absorption cross section functions of increasing realism. A very full quantitative examination of the results has been made, and the usefulness of the above diagnostic equation has been confirmed.

In a related study, supported by NSERC, two digital gas filter non-dispersive correlation spectrometers, GASCOFIL and GASCOSCAN have been developed for remote sensing of trace atmospheric species. These instruments operate over a spectral range from the ultra-violet to the near infrared. Their design, operating characteristics and performance in field tests will be described.

ABSTRACT FORM

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Project No.: 189PL Liaison Officer : M. Lusis Phone: 965-1634

KEY WORDS: Absorption Spectrometry, Atmospheric Monitoring, Tunable Laser.

Title: Measurements of Atmospheric Constituents By Tunable Diode Laser Absorption Spectrometry.

Abstract:

Tunable diode laser absorption spectrometry (TDLAS) operating in the 5 to 10 micron region affords a number of advantages for measuring these species. It is a universal method applicable, in principal, to any gas of atmospheric interest. Because of its high resolution, it provides positive identification with no interferences from other gases. By utilizing the long path length of a White cell it can detect most molecules at concentrations found in the atmosphere. It is a passive technique which can provide real time, in situ measurements, with a time resolution better than 1 min.

The application of the method to measurement of trace atmospheric constituents has three requirements: (1) the selection of an appropriate absorption line which usually involves a compromise between the line strength of the absorber and the operating characteristics of the diode, (2) the development of a calibration procedure for the target gas and (3) the development of procedures to ensure sampling integrity and tests to assure linearity between absorption signal and concentration of the target gas in the sampled air.

A field instrument which meets these requirements for NO, NO_2 and HNO_3 has been described by Schiff et al (1). Calibration and sampling procedures have subsequently been developed for SO_2, HCHO, H_2O_2 and NH_3.

A second laser head assembly was subsequently added to the system to permit a number of gases to be measured simultaneously. Further modifications included the incorporation of computer controlled operation and data acquisition and processing systems. Considerable improvements in background stability and, consequently, in detection limits was achieved by using temperature rather than current controlled line locking.

The modified system was used in a number of field missions and proved to have adequate sensitivity to measure most atmospheric species in rural and urban air. Additional sensitivity was required, however, to measure H_2O_2 during most of the year and the other gases in very clean air. A modified White cell and associated optics has been incorporated in the system and shown to provide detection limits of these gases of less than 100- pptv.

This upgraded system has also flow on an aircraft to sample oceanic and continental air in and above the planetary boundary layer.

References: (1) Schiff, H.I., Hastie, D.R., MacKay, G.I., Iguchi, T and Ridley, B.A., Envir. Sci. Technol., 17 352A (1983).

ABSTRACT FORM

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KEY WORDS: Aerosols, Respiratory System, Inahalable Particulates.

Title: Uptake, Distribution, and Clearance of Soluble Aerosols in the Human Respiratory System.

Abstract:

In humid atmospheres, soluble aerosols may grow in size as water condenses on the particle surfaces. The growth of soluble aerosols in the humid environment of the respiratory tract will affect the degree and site of deposition in the lungs. Since most of the ambient aerosol is hygroscopic, this has a direct bearing on the estimation of health effects due to air pollution. This study investigated the growth, deposition, and clearance of soluble aerosols in the human respiratory system.

Using a radioactive tracer, the study assessed the deposition of soluble aerosols when inhaled by a number of volunteers. Contrary to theory, most of the particulate deposited in the conducting airways of the lung. Furthermore, major pathways of aerosol clearance from the respiratory tract were traced. Two mechanisms, absorption in to the body fluids and mucocillairy clearance, were most important in removing soluble aerosol contaminants from the respiratory system.

ABSTRACT FORM

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Project No.: 142PL Liaison Officer : M. Salamone Phone: 235-5790

KEY WORDS: Mutagenicity, Air Pollution, Mutation Rates, Health Effects, Inhalable Particulates, Exposure.

Title: Experimentally Determined Mutation Rates in Lung as an Air Quality Standard.

Abstract:

A quantitative assay for the toxic effect of air-borne contaminants that is both relevant and inexpensive would be useful in establishing air quality standards. We are developing such an assay for carcinogenic air pollutants based on measurements of mutation in lung cells and tracheal cells in test animals.

Two approaches have been tried. The first is to assay mutations in the target cells themselves. Since these cells cannot be cloned quantitatively, traditional mutation measurements, which are based on cloning, are not feasible. Instead we have been using autoradiography to detect mutants resistant to diphtheria toxin, an agent that specifically inhibits protein synthesis. Since resistant mutants will continue to synthesize protein after exposure to the toxin, but normal cells will not, only the mutants will incorporate tritiated leucine and so be labelled. With this assay we have found reproduceable but small increases, approximately three-fold, in the frequency of mutant cells in Chinese hamsters exposed to urethane, a known lung carcinogen and to ethylnitrosourea, a catholic mutagen. These results make it clear that the optimal conditions for detecting mutants in the lung cells have not yet been found.

A second approach has been to culture the fibroblasts that are in close association with the target cells throughout the lung and measure the frequency of mutants resistant to azaguanine in them by the colony-forming technique. This assay demonstrated a dramatic and reproduceable increase in the frequency of mutants following in vivo exposures of the hamsters to ethyl methane sulphonate and diethylnitrosamine. This exciting finding is being very actively pursued to determine whether or not specific pulmonary carcinogens are also detected rapidly and easily. The results obtained with several such chemicals will be reported together with progress towards optimizing the autoradiographic assay.

ABSTRACT FORM

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KEY WORDS: Hamilton, Air Particulates, Health Effects, Respiratory System, Survey.

Title: The Hamilton Study: Effect of Fine Particles on the Respiratory Health of School Children.

Abstract:

Hamilton, Ontario, is an industrial city with a population of 300,000 situated at the western end of Lake Ontario. The level of particle pollution has historically been high, a portion of which has been attributed to the activities of Canada's two largest iron and steel mills located here. Although in the last two decades air quality has improved markedly, there has been a continuing community concern about the effects of air pollution on health. From 1979 to 1982, we carried out an epidemiological study of the respiratory health of a cohort of over 3500 elementary school children in whom we also determined the extent to which they were exposed to ambient particles of different sizes. Respiratory health was assessed by determining each child's respiratory symptoms and health history using a questionnaire administered to the parents. In addition, comprehensive tests of pulmonary function were carried out on the children at their schools. Particle size and concentration were measured using two networks: one of 7 to 9 Andersen 2000 cascade impactors, and another of 27 GMW Hi-Vol TSP samplers. Both networks were distributed over the area of the city. Other environmental factors thought to "confound" the relationship between respiratory health and air pollution were also examined, via information collected in the parental questionnaire; e.g. parental smoking, use of gas for cooking, socio-economic status. Results of a cross-sectional analysis of the data from the cohort in the second year of the study showed a strong effect of maternal smoking on the prevalence of cough and bronchitis, with little air pollution effect on these variables. Two pulmonary function variables, peak flow (adjusted for height) and maximum expiratory flow at 75% VC (adjusted for height) showed an association with the presence of fine particles.

ABSTRACT FORM

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Project No.: 212RR Liaison Officer : M. Salamone Phone: 235-5790

KEY WORDS: Genotoxicity, Air Pollution, Mice, Sister Chromatid Exchange.

Title: Biological Monitoring of Environmental Genotoxicity.

Abstract:

The SISTER CHROMATID EXCHANGE (SCE) assay has been modified so that wild mice can routinely be used to monitor the environment for general genotoxicity. The use of bromodeoxyuridine tablets and improvement of the staining procedure have permitted the processing of an adequate-sized sample (30 mice or more) at one time with consistently good results. This procedure has now been applied to wild mice collected from a number of localities in southwestern Ontario over the last three years. The annual temporal and geographic patterns have been similar from year to year. The SCE values/mouse are low in the early spring (prior to the spraying of crops with pesticides), high in the late spring (spraying period) and generally low in the summer (post-spraying period). The geographic pattern involves high SCE values in mice captured in the western part of the study area (Essex County) and lower values in those from the eastern section (Kent and Elgin Counties). Also we have examined the effects of a number of factors on SCE levels and their variability. These have included: short-term stress, age, genetic heterogeneity, some commonly used herbicides, several chemicals encountered in the plastics-molding industry and fumes in a diesel garage. Only chromic acid (plastics-molding industry) and diesel fumes significantly increased SCE values.

The MICRONUCLEUS ASSAY OF PERIPHERAL BLOOD was selected as a back-up system to permit corroboration of the SCE results. This assay was chosen because: 1) with fluorescence microscopy the typing of micronucleated cells is very straightforward and can be done rapidly, 2) the mouse is not sacrificed and blood samples from the same animal can be obtained at different times after treatment, 3) no pretreatment of animals is necessary prior to obtaining testable blood samples, and 4) a single recent (within 72 hours) exposure of an animal to a genotoxic agent can be distinguished from both an earlier exposure and chronic exposure. Furthermore, although most agents induce both SCEs and micronuclei there are some that cause the latter but not the former making the two tests complementary. So far a time-response curve has been developed for two compounds, cyclophosphamide and mitomycin C. Peak induction of micronuclei occurs at around 48 hours after injection of either agent. This appears to be about 12 hours later than induction of micronuclei in bone marrow cells. The micronucleus assay has been applied to wild mice being examined for SCE's as well as mice being used in several experimental situations.

The results of both tests will be presented, compared and discussed in detail.

(This research is supported by a grant from the Ontario Ministry of the Environment).

ABSTRACT FORM

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Project No.: 123PL Liaison Officer : W. Chan Phone: 965-4081

KEY WORDS: PAH, HiVol Denuder, Air Sampling, Organic Vapour.

Title: Field and Laboratory Validation of a HiVol Denuder for Minimizing PAH Oxidant Reactions.

Abstract:

Results of a recent study: "Evaluation of Alternatives to HiVol Sampling for Polynuclear Aromatic Hydrocarbons", by Concord Scientific Corporation for the Air Resources Branch, showed that a denuder efficiently removes ozone from an air stream prior to a HiVol filter. In a single experiment, the ozone denuder appeared to reduce on-filter reactions between ozone and captured PAH, as indicated by the significant drop in the number of oxy-PAH species in a protected filter compared to an unprotected filter. Additional verification of the efficiency of the denuder-HiVl system in reducing or eliminating reactions of collected PAH with ozone and other species (HNO_3) removed by the denuder was therefore required.

The objective of this study was to evaluate further the HiVol ozone denuder in terms of mass collection and the relative attenuation of PAH and PAH derivatives, the effectiveness for removal of NO_2 and HNO_3, and the identification of the oxy- and nitro-PAH contained in the extract of the denuder filter compared to a standard HiVol filter and to determine the lifetime of the denuder bundle. The primary purpose of the program was to identify the chemical species present on the protected versus standard filter and thus determine the effect, if any, of the denuder. Field and laboratory tests were to be performed.

The experimental data from this study have shown the following:

1. The denuder is effective not only for ozone, but also for nitric acid. Break-through of HNO_3 was found to occur only after 16,500 ppb-h exposure. The estimated lifetime respecting nitric acid would be about 70 days continuous operation. Within these limits, the removal efficiency for HNO_3 was 99% at room temperature and 85% at 0°C.
2. After 42 days continuous field operation with a mean ozone concentration of 22ppb, the denuder's efficiency for removing ozone was 85% for a laboratory ozone challenge concentration of 155 ppb and 90% removal efficiency for 50 ppb.
3. Similar particle catches for the standard HiVol and a denuder HiVol were obtained in two of three tests. In the third test the particle catches for denuder HiVol was lower (by 22%). Earlier tests had shown about 15% mass attenuation.
4. Analysis of extracts from standard and denuder HiVol field samples showed insignificant differences in the PAH derivative composition.
5. Laboratory tests showed that the denuder reduced the formation of oxygenated PAH derivatives within fairly broad analytical uncertainty.
6. Dynamic laboratory tests in which preloaded filters were challenged with nitric acid showed no differences in the PAH derivative fractions between samples.
7. Analogous tests on filters using static chamber exposure conditions for O_3, and HNO_3 and NO_2 separately showed no differences in the PAH derivative fraction compared to control filter.

Based on these results, the contemplated use of a denuder HiVol in a network would be justified only respecting protection provided by the removal of ozone.

ABSTRACT FORM

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KEY WORDS: Particulates, Air Pollution, Multi-element Analysis, Receptor Modelling, Neutron Activation Analysis.

Title: A Particle-Size-Specific Elemental Mass Balance for Apportionment of Ambient Aerosol Sampled with Multistage Fractionators

Abstract:

Receptor models for aerosol-emission source apportionment have received increasing attention during the past decade. However, the usual elemental models are often limited in their application and development especially in situations where there are several aerosol sources which have somewhat similar elemental microcomposition. A judicious use both of particle-size sampling and multi-elemental concentration measurements in a modified receptor model, for which we have defined the term "particle-size specific elemental mass balance, SSEMB" can facilitate the distinguishing of such similar sources. This has been demonstrated in this current research project - as detailed below.

The applied radioanalytical methods of instrumental photon and thermal-neutron activation analysis (INAA) have been adapted to determine total elemental concentrations of up to thirty chemical elements (including Al,As,Ba,Br,Ca,Cr,Fe,Mn,Na,Ni,Pb,Sb,Sc,Se, Ti,U,V and Zn) in six particle-size fractions of urban airborne particulate matter collected by Sierra cascade impactor. Both these analytical techniques are multi-elemental in nature, quite sensitive and reasonably non-destructive: all desirable attributes of methods for aerosol analysis given the small mass of material in each size fraction collected and, also, the need to achieve sufficiently low analytical variance to permit subsequent statistical modelling based on the multi-component concentration data obtained.

Hi-Volume air samplers fitted both with Anderson and Sierra 235 cascade impactor heads were used with coated cellulose substrates to partition urban air-borne particulate matter into 5 or 6 size fractions during typical 12 hour sampling periods at three locations in greater Toronto: Port Credit, Toronto Island and Eastern Avenue. Characterization of the material collected on the several impactor sages was performed by scanning electron microscopy.

Contrary to previous published reports (¹), the cellulose substrates used with these impactors did not cause marked distortion of the stage-by-stage collection characteristics of the impactor as both scanning electron micorphotographs and INAA performed on portions of vaseline substrate indicated a dramatic reduction in particle bounce-off from stage to stage. Considering this and the larger number of size fractions yielded by the Sierra unit when compared to the more widely-used dichotomous samplers, the value of our aerosol sizing method is clearly demonstrated.

(continued)

The particular-size distributions obtained in these studies of air particulates from the greater metropolitan Toronto region, such as the distributions of Al,As,Ca,Br,Mn,Pb, V and Zn revealed varying effects of both natural and anthropogenic sources of aerosol. While the majority of the elements studied exhibited particle-size distributions shifted either to mainly large (eg. Al,Sc,Zr) or mainly small particles (e.g. Br,Cl,Cu) which can be taken as generally indicative of physical ablation or high temperature combustion sources, respectively, the size distributions of several other elements (viz. Pb,Zn,As,Sb) exhibited different and unusual shapes in several sets of air particulate samples. Such unusual distributions were identified at a site near a lead smelter, incinerator and motorway where Pb sources ranged from fine particles from vehicle exhaust and variably-sized industrial emissions. These were used in a novel SSEMB model to aid in the accurate apportionment of aerosol among the colinear contributing sources involved.

References:

1. H. Sievering, M. Dave, P.McCoy, K. Walter, Environ. Sci. Tchnol., 12 (1978) 1435.

2. K. Willeke, "Performance of the Slotted Impactor", American Industr. Hygiene Assoc. J., Sept. 1975, 683-691.

ABSTRACT FORM

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KEY WORDS: PAH, Mutagenicity, Air Particulates.

Title: Mutagenicity of Complex Mixtures of Polycyclic Aromatic Hydrocarbons in Ambient Air Particulate Matter

Abstract:

Polycyclic Aromatic Hydrocarbons (PAH) are a particularly important group of carcinogenic pollutants in the atmosphere to which man and animals are exposed. Human exposure to PAH mixtures may produce carcinogenic effects depending on the ratios of the various strong carcinogens to weak - or non-carcinogenic constituents.

We tried to estimate the mutagenicity of the different PAH present in the Standard Reference Material (SRM) 1649 that was purchased from U.S. National Bureau of Standards. 13 PAH have been identified in the SRM 1649 and these are: Phenanthrene, Fluoranthene, Pyrene, Chrysene, Benz (a) Anthracene, Perylene, Benzo (b) Fluoranthene, Benzo (K) Fluoranthene, Benzo (a) Pyrene, Benzo (e) Pyrene, Benzo (ghi) Perylene, Dibenz (a, h) Anthracene and Indeno (1,2,3, -cd) Pyrene.

In vivo bone marrow micronucleus assay has been used as a short-term test to assess the mutagencity of individual PAH as well as mixtures of PAH that are present in SRM 1649.

LD 50/7 of SRM 1649 was found to be 535 mg/kg. No dose-related response was found in terms of number of micronucleated polychromatic erythrocytes with the individual PAH like Benzo (b) fluoranthene, Benzo (k) fluoranthene, and Benzo (ghi) perylene. There was response with the crude extract of SRM 1649, but not dose related. The mammalian assays were carried out with mice.

Some of the preliminary experimental results indicated 70% to 84% of inhibition when two promutagens Ba P and DMBA were employed together. No additive effect was observed when Ba P, DMBA and Benzo (ghi) perylene were employed in a mixture. Studies are in progress and updated results will be presented.

ABSTRACT FORM

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KEY WORDS: Ozone, Food Crops, Air Pollution Effects.

Title: Dose-Response Studies of Gaseous Pollutants of Food Crops.

Abstract:

A long-term dose-response study was conducted in a controlled environment facility using carrot 'Spartan Bonus' plants. Fifteen days old plants were exposed to either 0, 0.06, 0.12, or 0.18 ul l^{-1} of O_3 for 7 h one day each week for a total of 5 weeks. Shoot and root growth analyses were conducted on plants which were harvested one week after each exposure. Leaf area and leaf fresh and dry weights were significantly decreased by the 0.18 treatment after one exposure. Leaf injury was significantly increased by the 0.12 and 0.18 treatments after one week of exposure. Root fresh and dry weights were significantly decreased in the 0.12 and 0.18 treatments after the third week of exposure. By the fifth week of exposure, significant reductions in leaf and root parameters occurred in the 0.12, as well as the 0.18 treatments. No significant changes were detected in dry matter partitioning between the roots and shoots in any of the treatments.

An experiment was performed, using 14 days old tomato plants, to determine changes in plant growth and physiology following exposure to O_3 levels (0, 0.035, 0.070 , and 0.105 ul l^{-1}) below those that normally produce visible leaf injury. Leaf and stem growth parameters, stomatal conductance, and chlorophylls a and b were analyzed 3 days following the 7 h exposure. Neither growth nor chlorophyll was significantly affected by the treatments. However, stomatal conductance in the 0.105 treated plants immediately following the exposure. Three days after the exposure, stomatal conductance was significantly reduced in all the O_3.

Research was conducted to determine if comparisons could be made between indoor and outdoor O_3 responses of several crop species. Seeds of 4 soybean, 2 corn, and 3 wheat cultivars were obtained from the USEPA NCLAN program for indoor experiments. These same cultivars had been grown and subjected to O_3 treatments in open-top field chambers in NCLAN studies. In the present experiment, the seedlings were exposed to 0, 0.06, 0.12, or 0.24 ul l^{-1} of O_3 for one 7 h period in controlled environment facilities. The results suggested that a good comparison could not be made between indoor and outdoor experiments determining the effect of O_3 using these species.

ABSTRACT FORM

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Project No.: 70RR & 292PL Liaison Officer : R. Pearson Phone: 965-4516

KEY WORDS: Ozone, Beans, Air Pollution, Food Crops.

Title: Production of Ozone Insensitive White Bean Varieties

Abstract:

Ozone induced foliar damage of white beans has been estimated to reduce white bean seed yields by 7 to 12 percent in Ontario, and result in a monetary loss of $1,185,000. Previously, this project had identified genotypes of bean, including Gold Crop and French Horticultural Bean, with less sensitivity to ozone than is found in currently registered white bean cultivars. Thirty-five breeding lines were selected from among progeny of crosses between ozone insensitive beans and ozone sensitive registered cultivars based on growth chamber and field performance. These 35 lines and 6 parental check cultivars were screened for ozone sensitivity in growth chambers in Spring, 1986. Fourteen-day-old bean seedlings were exposed to 0.20 ppm ozone for 6 hours each of 4 consecutive days. On day 5, injury of the two unifoliate leaves was rated using the Horsfall-Barratt scale and the Digitized Video Image Analysis System. The DVIA system digitizes the video image of a bean leaf and determines the mean and standard deviation of pixel luminescences for that leaf image. Analysis of variance of the Horsfall-Barratt scores and video image data indicated that breeding line differences were significant. The standard deviation of pixel luminescences was in better agreement with percentage damaged leaf area (r=0.19). Breeding lines and parents were separated into four groups of ozone sensitivity using a k-means cluster analysis of the damaged leaf area estimates. The registered white bean cultivar Seafarer was placed into the most sensitive group, while Kentwood was placed in an intermediate group. Ex Rico 23 ranked in the least sensitive group. Twenty-two breeding lines were less sensitive than their white bean parent. Six were more sensitive, and seven showed no difference from their white bean parents. Improvement was most noticeable for breeding lines derived from the early white bean cultivars Seafarer and Kentwood. Five breeding lines derived from Ex Rico 23 maintained the low sensitivity of the parent line. Cluster analysis of the standard deviation scores from the video image data placed seven breeding lines in the next higher or lower sensitivity groups set by the visual assessment of damaged leaf area. The remaining 34 lines were identically grouped. The 35 selected breeding lines along with 5 new breeding lines and 8 check varieties were planted in the yield and ozone trials at the Agriculture Canada Harrow Research Stations and the Ridgetown College of Agricultural Technology Research Station in June, 1986. Ozone damage, yield and maturity data will be collected. Approximately 10 lines will be continued in advanced trials in 1987, and ultimately, one or two lines will be entered in provincial licensing trials in 1988.

ABSTRACT FORM

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Project No.: 116RR Liaison Officer : G. Diamond Phone: 965-4081

KEY WORDS: Nickel Carbonyl, Air Pollution, Analyzer.

Title: Nickel Carbonyl Ambient Monitor

Abstract:

The Ministry had a requirement for an ambient Nickel Carbonyl monitor capable of making measurements down to the Provincial limits.

The only commercially available Nickel Carbonyl monitor was not sufficiently sensitive to fulfill the Ministry's needs. Furthermore the manufacturer was not interested in upgrading their instrument in light of the expected market.

We took a commercial NO/NOx chemiluminescent analyser and modified it to measure Nickel Carbonyl. To measure $Ni(CO)_4$ rather than NO major changes were made to the plumbing of the instrument. An additional input to allow the addition of carbon monoxide to the air stream and a permeation based air dryer was added to the inlet of the instrument to remove problems encountered with water vapour. The filter in front of the photomultiplier was changed to give maximum sensitivity towards $Ni(CO)_4$ while discriminating against $Fe(CO)_5$ and NO. The reaction vessel was increased in size to improve sensitivity. A calibration protocol was developed to allow in-situ calibrations of $Ni(CO)_4$.

The instrument has shown a linear response to $Ni(CO)_4$ over an order of magnitude range of $Ni(CO)_4$ concentrations and has a detection limit of 10 ppt.

Notes: The original photomultiplier provided with this instrument catastrophically degraded during the testing of the instrument. It has been replaced with a Hamamatsu tube. This tube does not respond in the red so does not need to be cooled, thus the fuse on the cooler circuit has been removed. It is normal for this tube to have a high but stable dark current.

ABSTRACT FORM

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Project No.: 172PL Liaison Officer : J. Smith Phone: 323-5113

KEY WORDS: Particulates, Air Quality, Multi-element Analysis, Indoor-Outdoor Air.

Title: Elemental Composition of Air Particulates Inside and Outside a Building

Abstract:

Air particulates have been collected simultaneously outside and in several rooms inside a school in Kingston, Ontario for two week periods, one during the heating season and the other in the late spring. The time sequence of the deposition was obtained as a streak on nucleopore filters which moved past a 2mm x 4mm nozzle at 1 mm/hr. The elemental composition of the deposit was determined with particle induced x-ray emission, a non-destructive technique which is capable of measuring minute quantities (0.5 ng) of all elements with atomic number greater than 12. The elements Al, Si, S, Cl, K, Ca, Ti, Mn, Fe, Cu, Zn, Br and Pb were detected. Several factors, human motion, outside air load and human activity, determine the concentration of the elements inside the various rooms of the school. Models for the dependence of the concentrations on these factors have been developed. Through principal component factor analysis, several sources, such as soil, automobile emission and combustion were identified as contributors to the air particulates in all locations while specific sources, such as aerosols due to human activities, were found in some rooms.

ABSTRACT FORM

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Project No.: 190PL Liaison Officer : G. Marson Phone: 965-5776

KEY WORDS: Emission Monitoring, Organics, Sewage Sludge, Incineration, Stack Emissions.

Title: Continuous Emission Monitoring for Total Hydrocarbons at Sewage Sludge Incinerators.

Abstract:

Total hydrocarbon (THC) analyzers for use in stack monitoring are based on the flame ionization detector (FID).

A program was recognized in the operation of THC analyzers at sludge incinerators; frequently, the FID remains operational for only a few hours before failing and forcing system shut-down. To correct this situation, Amko Systems Inc., in consultation with the Air Resources Branch, undertook to research this problem.

Our monitoring package consisted of a heated dilution system (ADS), developed by us, that was connected to one ratfisch FID total hydrocarbon analyzer. Signal was connected to the strip chart recorder.

The ADS was designed to 1) coarse and fine filter the incoming sample, 2) proportion dilution air, with use of a differential pressure regulator, into the sample capillary and 3) progressively elevate the sample temperature as it is drawn towards the analyzer. The sample is, in this process, fed through the filters at approximately 130°C, into the capillary at 140°C and into the FID at 160°C. The problem of the condensation of high boiler organics is thus addressed.

The dilution ratio chosen for this facility was a moderate 1:1.

Results

The Dilution system functioned for a continuous time of 559 hours before requiring maintenance of a 15 minute filter change.

During the entire 32-day test period, the dilution ratio did not vary by more than ±2.5% of the initial value.

Zero drift was, for this purpose, negligible.

The result of this project indicates our heated dilution system to be a viable approach to achieving acceptable up-times for hydrocarbon analyzers in sewage sludge incinerators. (The system on location for the previous seven years did never operate for more than three days continuously).

ABSTRACT FORM

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KEY WORDS: Incineration, Flyash, Dioxins, GC/MS.

Title: Study of the Thermal Reactions of Polychlorinated Dibenzo-p-Dioxins on Flyash Particles under Incinerator Conditions.

Abstract:

Very little is known about the formation process mechanisms of chlorinated dibenzo-p-dioxins in municipal incinerators. The most acceptable mechanism is that they result from catalytic reactions on the surface of flyash particles in the incineration process. Some organic compounds and specifically chlorinated dioxins are known to undergo gas-solid reactions on flyash and have been shown to chemisorb onto the surface of flyash particles.

To investigate the possibility of gas-solid reactions producing chlorinated dioxins from precursor compounds, we constructed a simple flowtube apparatus consisting of a compressed gas supply, rotameter, a heated reaction zone containing exhaustively extracted clean flyash, a cooled impinger and a florisil guard trap. ^{13}C-labelled or unlabelled chlorinated phenols in solution were deposited on glass beads at room temperature. These beads were placed in the flowtube just upstream of the flyash. The one hour experiments were done at 300°C under a 10 mL/min. nitrogen flow.

Chlorinated dioxins with ^{13}C were recovered from the flyash and from the impinger rinse after passsing ^{13}C-labelled pentachlorophenol through the flyash from a refractory-wall incinerator located in Toronto. A similar experiment using flyash from an energy recovery municipal incinerator in Japan yielded much lower amounts of chlorinated dioxines. Only minor amounts of octachlorodioxin were produced when using a bed of ground firebrick and an empty flowtube, indicating the presence of the catalytic flyash is necessary to form the full range of dioxin congeners.

Experiments using 2,4,5-trichlorophenol and 3,4,5-trichlorophenol yielded chlorinated dioxin isomer distributions very different from each other and from that arising from pentachlorophenol. The fact a distribution of isomers is observed, rather than a single product from the condensation of two tri-chlorinated phenols, indicates that both chlorination and dechlorination reactions are occurring on the flyash surface. The production of chlorinated dioxins from 3,4,6-trichlorophenol is interesting since this compound does not possess a chlorine ortho to the hydroxyl group, which is necessary for condensation and ring closure to form dioxins.

Further experiments are underway to find correlations between the physical and chemical properties of these flyashes and their activity with respect to the production of dioxins.

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KEY WORDS: Sulphur Dioxide, LRTAP, Sudbury, Air Pollution, Stack Emissions.

Title: Study of the Spatial Distribution of the Impact of Sudbury Smelting Emissions.

Abstract:

The two mining and smelting operations near Sudbury are the source of greater than half of the total SO_2 emissions in Ontario (Tang et al, 1984). These releases are examined to improve the understanding of the resulting areal deposition patterns. The intent of this focus is three fold:

(i) to develop contouring procedures which will allow generalization of point-specific measured information and to indicate percentages of regions which would be impacted by various levels of remedial control-technologies;

(ii) to better understand the long-term deposition levels, reflecting meteorologic variability on annual and seasonal levels; and,

(iii) to compare with monitoring station records to observe whether additional and/or fewer monitoring stations may be appropriate.

ABSTRACT FORM

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KEY WORDS: Building Wake, Darlington, Nuclear Power Plant.

Title: Characterization of Building Wake Effects at Darlington Nuclear Generating Station using Sulfur Hexafluoride (SF6) as a Tracer.

Abstract:

A field experiment was conducted at Darlington nuclear generating station to investigate the effects of the structure on the effluents released from the top of the vacuum building and the power station building. Sulfur hexafluoride (SF6) was released for three to four hours, and sampling was carried out on fixed arcs and with a real time monitor mounted in a mobile van. Simultaneous meteorological data was collected with a doppler acoustic sounder, and four instrumented meteorological towers located on the site.

Under moderate winds, mixing in the building wake was quite evident. The plume was observed to be well mixed and well defined. Under light winds the plume was not discernible and under strong winds, large fluctuations in (SF6) concentration were observed at a fixed location. Analysis of the data is under way to quantify the impact of the vacuum building and the generating station building, on the dispersion of effluents released from top of these structures.

ABSTRACT FORM

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Project No.: 165Pl Liaison Officer : B. Birmingham Phone: 323-5105

KEY WORDS: Organics, Toxicity, Dioxins, Health Effects, Immunosuppression.

Title: Assessment of Toxicity of Ingested and Inhaled Haloaromatic Hydrocarbons

Abstract:

The effects of environmental exposure to a variety of haloaromatic hydrocarbons remain undefined in a great many instances. We have studied the effects of chronic exposure of laboratory mice to 2,3,7,8-tetrachlorodibenzo-p-dioxin (2,3,7,8-TCDD) over a period of 6 years and have shown that the most sensitive index of exposure is suppression of the immune system. Specifically, TCDD acts on the thymus gland, an organ of the immune system in which T lymphocytes mature, to stimulate the production of suppressor cells. These suppressor cells inhibit the generation of cytotoxic types of T cells that defend the body against certain types of virus infections. Interestingly, Aroclor 1254, a mixture of PCB's as well as the isomer 3,4,3',4'-tetrachlorobiphenyl that can bind to the receptor molecule for TCDD that is found in the thymus can also suppress killer cell generation. Two aspects of this work have been of particular interest. First, thymus atrophy which occurs with aging leads to resistance to suppression by low dose (12 pM/kg) TCDD. Second, there appear to be significant differences in the effects of TCDD when given orally rather than by the usual method (i.e. injection ip). With oral TCDD dosing, suppressed killer cell responses were confined to the spleen and other lymphoid organs where immune responses occur such as lymph nodes were spared. Inhaled smokes containing haloaromatic hydrocarbons should be deposited in bronchial mucus which is then raised up to the larynx by cilia and swallowed. Therefore, inhaled haloaromatics or haloraomatics in water or food would be expected to produce a more localized immunosuppression than when artificially injected in a laboratory test. No data currently exists to show whether the wide variety of haloaromatics to which one may be exposed in the environment will produce similar effects to those seen using 2,3,7,8-TCDD, i.e. localized rather than systemic suppression.

In this project which commenced 1 June 1986, the differences between the effects of oral exposure and parenteral injection of a variety of haloaromatics will be defined using sophisticated techniques for measuring suppression of killer cell generation. A variety of compounds will be tested, including 2,3,7,8-TCDD, 1,2,3,7,8-PCDD, 1,2,3,4,7,8-HCDD, 2,3,7,8-TCDF, 2,3,4,7,8-PCDF, and 2,3,4,6,7,8-HCDF. Results from studies of 2,3,7,8-TCDD should be available by November 1986 and for the other compounds, by June 1987. This information should prove useful in determining the possible significance of environmental exposure to these compounds particularly as it impacts on prediction of biologic (toxic) effects and the setting of "no effect" dose limits.

ABSTRACT FORM

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Project No.: 219PL Liaison Officer : W. Chan Phone: 965-4081

KEY WORDS: Air Pollution, Health Effects, Lung Function.

Title: Dose Response for Selected Environmental Air Pollutants on Selected Populations.

Abstract:

A study has been initiated to examine health effects of air pollution on runners during training runs in downtown Toronto. The runners are at potentially higher risk to adverse effects in areas having pockets of higher pollution because of their higher ventilatory rate. Thus the substantial and vigorous exercise increases the dose of most pollutants thereby increasing exposure. Furthermore, when they are running alongside busy traffic routes, as is often the case, the concentration of pollutants can be high (e.g. carbon monoxide). Exposure is also exacerbated by the fact that at these higher ventilatory rates they often breathe through the mouth, bypassing the normal filtration mechanism of the nose.

Subjects are being selected from a running club which carries out weekly training runs (of 16 kms) covering an area from downtown Toronto and along the Lakeshore corridor. Pulmonary function [forced vital capacity (FVC), forced expiratory volume in one second (FEV_1) and forced expiratory flow at 50% and 75% of expired vital capacity FEF_{50} and FEF_{75}%VC)] and carboxyhaemoglobin (COHb%) are measured before and after training runs; individual performance, subject evaluations, respiratory symptomology and other health/illness information are also obtained. Pollutant measurements include sulphur dioxide (SO_2), nitrogen dioxide (NO_2), ozone (O_3), carbon monoxide (CO) and suspended particulate matter along with environmental covariates (temperature humidity, wind velocity, wind direction) for each training run. Existing central Toronto air pollution monitoring network data (central MOE) is supplemented by portable personal multipollutant samplers (for SO_2, NO_2 and respirable particulate matter) placed at the central station (GMOE), and carried on bicycles following alongside the runners (mobile GAGE).

Health effects of air pollution will be examined by: 1) Establishing if a difference exists between: 1. stationary monitoring at a central downtown station; and 2. mobile sites monitoring to approximate personal exposure (on bicycles, traveling alongside runners) during training runs. 2) Establishing if an impairment in pulmonary function, (FVC, FEV_1, FEF_{75}, FEF_{50}), an increased COHb%, or increase in respiratory symptoms occurs due to exposure to pollutants in Toronto, during training runs. 3) Evaluating by multiple regression analysis any changes in lung function, exercise performance, COHb% and symptoms with the level of pollutants (e.g. CO, NO_2, SO_2. respirable particulate matter) for each of the above monitoring "networks" with control of wind velocity, thermal load (wet bulb, dry bulb, radiant temperature, combined as WBGT of Minard) and water deficit of atmosphere as covariates. 4) Relating sensitivity to pollutants as measured by the multiple regression coefficients obtained in 3) to general health effects such as sick days and symptoms.

ABSTRACT FORM

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KEY WORDS: Air Quality, Multi-element Analysis.

Title: Tree Ring Analysis Using PIXE

Abstract:

We have investigated whether tree rings record annual pollution levels. Element concentrations in cores from pines both upwind and downwind of the Sudbury smelters have been measured using PIXE and an external beam proton micorprobe. Downwind cores contained higher levels of Na, Mg, Al, S, Ti, Fe , Cu and Zn, but showed no indication of the INCO stack installation in 1973. Higher concentrations of Al in downwind trees may result from lower soil pH induced by the local contribution to acid precipitation. Pine cores showed variations in K, Ca and Mn concentrations throughout the growing season with levels higher by a factor of 2-3 in the less dense spring wood. In a second study, several maple cores from the Muskoka region were analyzed. Some of these cores were from trees which showed stress, possibly resulting from acid rain. Normal and stressed trees at the same site did not have significantly different elemental levels. In both pines and maples, high S concentrations were detected near or in the bark, indicating the function of this layer as a barrier to air pollutants.

ABSTRACT FORM

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Project No.: 117RR Liaison Officer : A. Szakolcai Phone: 965-4081

KEY WORDS: PAH, Coke-Oven Emissions, Air Pollution, Mutagenicity, Organic Analysis.

Title: To Investigate the Short-Term Test, Mutagenicity and Chemical Composition of Benzene Extractable Fraction of Coke Oven Emissions

Abstract:

This study was "Phase I" and was presented at the 1985 Technology Conference.

ABSTRACT FORM

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Project No.: 258RR Liaison Officer : L. Kende Phone: 323-4458

KEY WORDS: Noise, Impact.

Title: New Software Package for C.S.A. Standard Z107.55: Recommended Practice for Prediction of Sound Levels Received at a Distance from an Industrial Plant.

Abstract:

A new software implementation for C.S.A. Z107.55 has been developed to allow prediction of the community noise impact of new or expanding industrial plants before they are built. This paper discusses how the software was prepared and how it is used. It also discusses how results compare with measurements.

ABSTRACT FORM

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KEY WORDS: Stack Emissions, Emission Monitoring, Sulphur Dioxide.

Title: Determining SO_2 Mass Emission Fluxes by Stack Scanning: Phase II

Abstract:

MONITEQ and the Air Resources Branch of the Ontario Ministry of the Environment have undertaken a program to evaluate the feasibility of using the MONITEQ Plumetracker from a fixed platform to remotely measure SO_2 emissions from stacks. The Plumetracker, which is normally deployed from a vehicular platform in an upward looking mode, has been mounted on a scanning tripod and is being used to scan across the stack mouth to measure the SO_2 emissions. The study program is being conducted using a small test stack for which the parameters under study can easily be controlled and their effects measured. Parameters being investigated include; plume opacity, background sky condition, viewing angle, plume rise and the intensity of the background UV radiation.

To date the results show a good correlation between the emission levels determined by the Plumetracker and the actual emissions measured by an in-stack monitor. The relationship is linear and very near one to one for stack concentrations up to 1500ppm. Initial results with respect to plume opacity, however, indicate that increased plume opacity has a detrimental effect upon the relationship. At this time the exact cause and magnitude of the measurement error is not known.

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KEY WORDS: Organic Vapour, Air Sampling, Volatile Organics.

Title: A Study of Adsorption Tube Storage and Sample Handling Techniques for Organic Vapour Measurements.

Abstract:

Measurements of trace organic components in ambient air samples often involve preconcentration on a sampling medium and subsequent laboratory analyses. The objective of this study was to assist MOE in determining optimum conditions that can be used in the handling and storage of adsorbent cartridges in order to maintain sample integrity.

Cartridges containing either Florisil/Carbosieve or Tenax/Silivalite adsorbent combinations were evaluated by dynamically loading six types of organic vapours onto the adsorbents and analyzing after subjection to various types of storage routines and transport between laboratories. Analysis of variance was used to evaluate optimum handling and storage protocols.

From the results of the study, the overall performance of the Florisil/Carbosieve cartridge generally was better than the Tenax/Silicalite cartridge with respect to quantification of the target constituents. On the other hand, the latter adsorbent combination retained most of the compounds for longer periods of time. Although some data variability occurred, the more volatile aliphatic species were usually less retained by the adsorbents during storage than the aromatic compounds that were studied. Sample integrity was found to be more significantly affected by storage duration than by other factors that were considered, such as storage temperature and initial concentrations of compounds. The results implied that analyses should be done within one week of collection for some of the volatile species, and the use of a portable cooler is recommended so as to avoid temperature excursions during transport prior to analysis.

ABSTRACT FORM

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KEY WORDS: Health Effects, Air Pollution, Exposure, Air Particulates.

Title: Health Effects on Asthmatics of Daily Variations in Air Pollution

Abstract:

The burden to health of low level air pollution exposure is still uncertain. Until recently, studies of health effects of air pollution have largely relied on exposures measured at fixed outdoor sites. However, vertical horizontal differences in air pollution can exist, outdoor air can differ substantially from indoor air and the relationship between the two is not necessarily fixed. Thus levels of air pollution measured at fixed outdoor sites often do not reflect the levels actually inhaled by an individual i.e. "personal exposure". Effects are often documented using severe response variables which would tend to ignore minor fluctuations in disease in, for example, people with asthma. The definition of disease groups e.g. asthma, emphysema, chronic bronchitis is also often not clearly established. A study was undertaken to address these problems.

The objectives were to assess exposure by both personal monitoring (P) and at a fixed air pollution monitoring site (GMOE) in downtown Toronto, and to examine the relative strengths of the two estimates of exposure as demonstrated by their association with measures of health effects (pulmonary function). Small multipollutant samplers for nitrogen dioxide (NO_2), sulphur dioxide (SO_2) and either total suspended particulate matter (SPM) or respirable particulate matter (RSP) were carried by volunteer asthmatic subjects (P) and on each day of monitoring a sampler of the same design operated at a downtown Toronto air pollution monitoring station (GMOE). Subjects were visited on up to 20 days; pulmonary function (spirometry) was assessed in the morning at the beginning of air pollution monitoring and again at the end of the day when monitoring was terminated; a questionnaire was completed (symptoms, medications, daily activities and exposure to other potential irritants). Each subject was monitored in both winter and summer on up to 10 days in each season.

Cross-sectional analysis is often employed to establish a relationship between exposure to toxic substances and response. In this study, this consists of correlating across individuals, air pollutant concentrations with measures of health. A serious drawback to such an analysis is the confounding influence of a cohort effect which can lead to paradoxical findings such as healthier individuals being found associated with higher levels of pollution. A longitudinal analysis attempts to circumvent this problem by measuring within individuals the relationship between exposure and response.

Using a longitudinal analysis of the relationship between pulmonary function and particulate matter, there was a season effect. There was a tendency for the slope of the relationships between pulmonary function and particulate matter to be negative in summer and positive in winter when the personal exposure monitoring data were used (P.)

(continued)

These trends were not observed when the exposure data from the fixed air pollution site (GMOE) were used in the analysis. Using a cross-sectional analysis correlating mean pulmonary function with mean particulate exposure, there were no significant correlations using either personal (P) or fixed (GMOE) monitoring.

These results along with those of our previous studies with other air pollutants (e.g. NO_2) strengthen our conclusions that in terms of assessing health effects of air pollution, assessments of personal exposure must be made, season of the year influences response and that both study design and method of analysis of the data (cross-sectional versus longitudinal) are important in interpretation of the data.

SECTION B

WATER QUALITY RESEARCH

ABSTRACT FORM

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KEY WORDS: Water Treatment. Trace Organics, Drinking Water, Activated Carbon, Great Lakes, Contaminant Removal.

Title: Trace Organic Contaminant Removal From Drinking Water

Abstract:

As public concern for the quality of drinking water in Ontario continues to grow, considerable research has been undertaken to re-examine conventional treatment methodologies as well as alternate processes for the removal of trace levels of organic chemicals, including adsorption by granular activated carbon (GAC).

This project has been undertaken to determine the following:

- the effectiveness of optimized conventional drinking water treatment for the removal of trace organic contaminants;
- the effectiveness of activated carbon adsorption removals of trace organic contaminants when used in the add-on contactor mode.
- process operational parameters for the optimized operation of full scale water treatment plants and GAC adsorbers used in the add-on mode for organics removal;
- process operational parameters for the optimized operation of full scale water treatment plants and GAC adsorbers used in the add-on mode for organics removal.

Jar testing and pilot plant operations are being conducted on site at the Niagara Falls Water Treatment Plant, using the Niagara River as the raw water source.

In this paper the results of the jar testing program to select chemicals to optimize the conventional treatment process for organics removal are discussed. Further the conventional treatment process evaluation methodology and results are discussed based on the operation of the pilot plant.

ABSTRACT FORM

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KEY WORDS: Groundwater, Nitrate Removal, Alliston.

Title: The Role of Organic Carbon in Controlling the Occurrence of Denitrification in Groundwater.

Abstract:

The role of organic carbon in controlling the occurrence of denitrification in two sandy, unconfined aquifers beneath agricultural land in Southern Ontario was investigated. Initial field monitoring showed denitrification to be an active process in an aquifer with a watertable close to ground surface, but to be relatively unimportant in a second aquifer with a much deeper watertable. It was postulated that the occurrence of denitrification was controlled by the availability of labile organic carbon. Profiles from ground surface to below the watertable of solid and dissolved organic carbon, and the ability of subsurface materials to support denitrification in the laboratory were generated. The results indicate that the ability of subsurface materials to support denitrification depends on the size of the organic carbon pool, and that denitification is carbon-limited at depth.

The rate of denitrification was measured in-situ in both aquifers, with and without the addition of organic carbon. Denitrification occurred without but was enhanced by, the addition of organic carbon at the denitrifying site. This indicates that although sufficient carbon was present to support denitrification, the rate was limited by carbon availability. At the non-denitrifying site denitrification did not occur unless organic carbon was added. This demonstrates that the non-occurrence of denitrification in this aquifer is due to the lack of a sufficient source of organic carbon for denitrifying bacteria. Denitrification was not limited at either site by the absence of denitrifying bacteria.

ABSTRACT FORM

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KEY WORDS: Health Effects, Drinking Water, St. Clair River, Birth Defects.

Title: Reproductive Outcomes in Southwestern Ontario, 1980 to 1985

Abstract:

This epidemiologic study, supported jointly by the Ministry of the Environment and the Ministry of Health, was designed to determine if drinking water from the St. Clair River was associated with increased risks of adverse outcomes of pregnancy and mortality in the first year of life. The outcomes of interest include: spontaneous abortion, stillbirth, low birth weight, selected congenital anomalies and perinatal, neonatal and infant mortality. First, the frequencies of these outcomes in the populations of Kent and Lambton Counties will be compared with those of the Ontario Southwest Region and the Province as a whole to determine if any excesses occurred. Second, the approximately 400 mothers in Kent and Lambton Counties who experienced, or whose children experienced, abnormal outcomes and a like number of individually-matched control mothers will be interviewed to assess their sources of drinking water during the index pregnancy and to document the frequencies of several other variables known to be associated with the outcomes of interest. Third, this study will examine the relationship between the occurrence of adverse outcomes and specific chemical spills by comparing the outcomes of pregnancy in a cohort of exposed women with those of a matched cohort of unexposed women.

ABSTRACT FORM

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KEY WORDS: Toxicity, Organics, Aquatic Organisms, Hazardous Contaminants.

Title: Organic Contaminant Structure-Property-Toxicity Relationships for Aquatic Organisms.

Abstract:

Two intercalibrated toxicity test systems with Daphnia and Artemia have provided consistent acute lethality data for hydrocarbons and chlorinated hydrocarbons in aqueous solution. Significant quantitative structure-activity relationships (QSARs) have been and continue to be established with these tests for several classes of pollutants which are of concern to the MOE. These QSARs can provide information which is of assistance in the formulation of Provincial Water Quality Objectives. These empirically-derived QSARs are used to validate and refine proposed toxicity models or simple "rules of thumb", which in turn provide estimates of toxicity based on properties of the chemical, for situations in which experimental toxicity data are unavailable. The importance of molar volume for estimating toxicity has recently been assessed (by re-analyzing our data and that of other workers) and will be discussed in terms of these toxicity models.

Since pollutants most often occur at sub-lethal levels and in mixtures, QSARs are being developed to treat such situations. One aspect is the development of a 7d life cycle test with Ceriodaphnia to provide chronic toxicity data for single compounds and simple mixtures. This work will be described and discussed in a QSAR framework.

ABSTRACT FORM

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KEY WORDS: Bioassay, Bioindicators, Toxicity, Metals, Fish, Rats, Exposure, Enzymes, Effects.

Title: Effect of Lead, Cadmium and Mercury on the Tissue of Young Fish and Rats: Development of a Bioindicator.

Abstract:

Exposure of fish to heavy metals in the laboratory, in static and flow bioassays, and in Ontario lakes, has been studied by measuring key enzymes involved in growth. There has been a scarcity of information on disturbances of the function of protein synthesis, energy-producing glycolytic enzymes and membrane interfacial enzymes in fish following low and high levels of toxic metal in the water. Thus we are correlating these activities with the metal levels in the animal in order to develop a more sensitive bioindicator test.

Fish exposed to Hg (30 ug/l) for six weeks exhibited statistically significant decreases in the enzymes of protein synthesis both in the liver, and also in the muscle, thus indicating an important reduction in the capability for growth. Fish from impacted lakes showed similar results.

Shorter exposure to higher Hg levels resulted in similar disturbances of protein synthesis. Low levels of Hg (e.g. 0.1 ug/l) trigger mRNA in fish liver for such activities as metallothionein gene expression.

Four glycolytic enzymes were measured in fish livers and muscle after exposure to Hg (30ug/l) for 3 or 6 weeks, and in fish from impacted lakes. Lactic dehydrogenase (LD) activity and glyceraldehyde-3- phosphate (GAP) dehydrogenase activity were decreased up to 50% under the most severe conditions.

Three "marker" enzymes of the membrane interface between the cell and its extracellullar environment were also studied because: (1) heavy metals such as Hg are believed to disrupt the integrity of the membrane, and (2) these enzymes might be useful for easily conducted field assays. Contrary to what was expected, only modest effects of heavy metal exposure were observed in one of the three enzymes: &-glutamyl transpeptidase. This enzyme plays an important role in the transport of amino acids in tissues.

Exposure of fish to combinations of Cd (0.25ug/l) and Pb (25ug/l) with Hg (0.25 ug/l) did not exhibit a synergistic effect upon the protein synthesis and glycolytic enzymes, thus confirming separate experiments on mammals.

The results of this work show that we can use certain enzymes as sensitive indicators of Hg toxicity.

ABSTRACT FORM

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KEY WORDS: Toxicity, Metal Contamination, Fish, Water Quality, Criteria.

Title: In-Situ Assessment of Mixed Copper and Zinc Impacts on White Sucker (Catastomus commersoni) Populations in Several Northern Ontario Lakes: An Evaluation of the Environmental Health Approach to Validating Water Quality Criteria.

Abstract:

Several lakes in the Manitouwadge district of Northern Ontario exhibit elevated levels of copper (11-13 ug/l) and zinc (220-236 ug/l) associated with mining activities. Since reproductive capacity may potentially represent the most toxicant-sensitive facet of a fish's life history, white sucker populations in the Manitouwadge district were examined for evidence of reproductive impairment associated with their chronic exposure to elevated metals. Fish from metal contaminated lakes showed decreases in length, weight and growth relative to the control site. They also exhibited an increased heptosomatic index and an increased incidence of failure to spawn. Although there were no demonstrated differences in fertilization rate in the laboratory, or in situ, this study suggests that there are significant impacts of chronic exposure to waterborne metals which are not evident from a cursory examination of reproductive potential. The increased relative fecundity, decreased egg size, increased milt volume, normal fertilization rate and natural fungicidal properties of waterborne copper appear to result in the presence of enormous numbers of sucker eggs on the spawning beds of metal contaminated sites. Eggs collected from fish at contaminated sites hatched into larvaelarvae which exhibited significantly decreased length and weight relative to control sits, as well as increased developmental rate, poorer conversion to exogenous feeding and a marked decrease in survival time in the absence of food. It is unclear at this time whether a further decrease in egg size evident after in-situ fertilization would result in a reduced recruitment to the lake population, despite an apparent increase in the numbers of eggs released. Although eggs hatched in the laboratory were never exposed to metals, larvae coming from contaminated sites were consistently more resistant to toxic levels of copper than were control larvae, except for a brief period during transition to exogenous feedings. Effects of both age and food availability were noted on both the tolerance and resistance of the larvae to copper exposure.

ABSTRACT FORM

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Project No.: 149PL Liaison Officer : T. Ho Phone: 323-4980

KEY WORDS: Contaminant Fate, Fugacity, Hazardous Organics, Sewage Treatment.

Title: The Fate of Toxic Organic Chemicals in Sewage Treatment Plants.

Abstract:

A predictive model describing the fate of organic chemicals in a water pollution control plant has been developed, based on the "fugacity" modelling system. By estimating a prevailing fugacity in each of the primary, aeration, and secondary settling tanks, chemical concentrations in the water, air, and sludge can be calculated. Thus fluxes can be estimated and a mass balance assembled.

Comparison of the fugacity model with the predictive fate models developed by Blackburn, et al. and Roberts, et al. and other workers show good agreement.

The fugacity model was also subjected to tests of validity by the following methods:

1) conducting laboratory-scale experiments for chemical stripping, stripping-sorption and stripping-sorption and biodegradation and comparing experimental results with the predicted values.

2) comparing the fugacity model predictions with data obtained form the literature, and from full-scale water pollution control plants.

In all cases, it was observed that the model predicted the fate of organic chemicals with fair accuracy based on reasonable estimates of biodegradation rate constants. It is concluded that the model can be used to give estimates of the fate of organic contaminants in treatment plants.

ABSTRACT FORM

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KEY WORDS: Toxicity, Zooplankton, Pentachlorophenol.

Title: Toxicity of Pentachlorophenol to Zooplankton

Abstract:

A static with renewal chronic toxicity test was used to evaluate the impact of sublethal concentrations of pure (99.9%) pentachlorophenol (PCP) and a technical (82.0%) formulation of pentachlorophenol on the life history criteria of Daphnia magna. The daphnids used in the experiment were produced by a cohort of adults exposed to the test conditions in an environmental chamber (temperature - 20.0 ± 1°C; photoperiod - 16 light:8 dark h). The experimental design included three concentrations of pure and four of technical PCP. There were 20 daphnids in each treatment, one daphnid per beaker with 80mL of test solution in each beaker. Test solutions were made form the stock solutions of PCP (1,000 mg/L) by dilution with aerated well water and an acetone equivalent of the maximum PCP concentration served as controls. Test solutions were renewed every second day at which time the organisms were fed 2.5 mg green algae/L. The experiment was conducted over the entire lifespan of each daphnid (max. 164 d) and the impact of PCP on longevity, time to appearance of the primiparous instar, time to release of first brood, number of young produced per daphnid, number of moults and production of ephippia was evaluated. The results of this experiment will be summarized and presented in a poster presentation pending analysis of these data.

ABSTRACT FORM

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KEY WORDS: Clams, Biomonitoring, Water Quality, Great Lakes.

Title: Development of a Standard Clam Biomonitoring Methodology for the Detection of Trace Contaminants within Water of the Ontario Great Lakes Region.

Abstract:

Clams have been used for several years by the Ontario Ministry of the Environment for the detection of trace contaminants of several types. The method has proved successful in locating contaminant plumes and cross-boundary contamination in rivers. The method has two advantages over strictly chemical monitoring. The first is that the results are time-integrated over the entire exposure period and the second is that it yields a direct measurement of a biological effect.

The source of clams to date has been one of the Kawartha Lakes, Balsam Lake. **Elliptio complanata** is the species that has been used until now. Part of our work has involved searching for new sources of uncontaminated clams, possibly clams of other species.

The rest of our work has been experimental in nature. There was a need to determine what effect, if any, certain factors have on the uptake of trace contaminants. Choosing Niagara-on-the-Lake as an experimental site, we have looked at the effects of different methods of transportation and deployment of clams and preservation of clam tissues on measured uptake of PCB's. Different methods of transportation included transporting clams at various temperatures in water or merely moist in air. The deployment methods that were tested involved different types of clam cages in which clams may filter river water to a greater or lesser extent. Preservation methods included storage of live clams on ice for a short period of time and immediate shucking followed by freezing on dry ice. We have also experimentally varied the temperature of the river water to see the effect of this variable on PCB uptake.

ABSTRACT FORM

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Project No.: 105PL Liaison Officer : T. Ho Phone: 323-4980

KEY WORDS: Sewage Treatment, Chlorination, Water Quality, Micro-organisms.

Title: Evaluation of Data on the Effects of Hydraulic Characteristics and Effluent Chlorination on the Incidence of Micro-Organisms of Public Health Significance in Receiving Waters.

Abstract:

The bacteriological impact of treated municipal effluent discharges to natural water bodies was analyzed. The studies used data gathered for the Ontario Ministry of the Environment by BEAK Consultants Limited during 1979-80 at the following sites:

- Thames River at Ingersoll
- Grand River at Grand Valley
- Otonabee River at Peterborough
- Lake Ontario at Port Hope

The review of raw data and the analyses focused on three objectives:
(1) selection of mathematical models and evaluation of their applicability;
(2) determination of travel times in receiving waters at which the total and fecal coliform (TC and FC) densities are reduced to 1000/100 mL, respectively, for both chlorination and nonchlorination periods; and
(3) establishing probabilistic distributions of pathogenic bacterial densities when (a) TC density range is 100 to 1000/100 mL or FC density range is 10 to 100/100 mL, and (b) TC density range is 1000 to 10,000/100 mL or FC density range is 100 to 1000/100 mL.

The state-of-the-art models suitable for the studies were reviewed in conjunction with the available data. The plug flow model was selected to be suitable for each river site. The lake site had large fluctuations and/or insufficient information, and hence, the data were not analysed. Plug flow model predictions for individual sampling days at each river site were in reasonable agreement with measured values in most cases within a factor of one-half log cycle.

The travel times at which the TC and FC densities reach 1000/100 mL and 100/100 mL, were smaller for the disinfected effluent discharges compared to the nondisinfected discharges and were affected by receiving water densified of TC and FC.

The correlations between the pathogenic and indicator bacteria were very poor for the Grand and Thames River sites. The Otonabee River data showed correlations between: (a) Klebsiella and TC; (b) P. aeruginosa and FC; and (c) Klebsiella and FC when the data are partitioned to eliminate low values biases and to consider the sensitivity of the bacterial density determination.

ABSTRACT FORM

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Project No.: 18PL Liaison Officer : W. Lewandowski Phone: 323-4984

KEY WORDS: Listowel, Sewage Treatment, Effluent, Marsh Treatment.

Title: Listowel Artifical Marsh Treatment Project

Abstract:

Five separate cattail (Typha spp.) marsh treatment systems, occupying a total area of 8670 m^2, were operated for four years (1980-1984). Several different marsh designs and two pre-treatment types, namely, complete-mix aeration cell effluent (average BOD5=60 mg L^{-1}) and lagoon effluent (average BOD5=20 mg L^{-1}), diverted from the existing Town of Listowel sewage works, were tested. The method of pre-treatment was shown to influence marsh operation and the quality of the final marsh effluent. Channelized marshes yielded the highest treatment efficiencies as this configuration provided greater control over flow distribution and wastewater retention time. Removal efficiencies declined when the hydraulic detention time, regulated by seasonal adjustments in water depth, deviated from the range of 7-14 days.

Marsh effluent quality achieved in the experimental systems was at levels between conventional secondary and tertiary treatment. The four year annual average effluent quality in the channelized marshes in terms of BOD5, SS, TP and TKN was 7.6, 9.2, 0.5 and 6.2 mg L^{-1}, respectively, in the system receiving lagoon effluent (System 3) and 9.6, 8.0, 0.6 and 8.7 mg L^{-1}, respectively, in the system receiving aeration cell effluent (System 4).

Large BOD reductions were maintained throughout the year, including winter months when average wastewater temperatures were less than 2°C. Elevated ammonia, hydrogen sulphide and phenol levels in the marsh effluent in summer and at the end of the winter season were attributed to anaerobic conditions, whereas low temperatures appeared to be the major factor in decreased ammonia removal in the winter months. The observed decline in annual phosphorous retention suggests progressive saturation of the phosphorus adsoption capacity of the sediment. Large reductions in fecal bacteria were achieved in the marshes although in some months levels exceeded Ministry objectives for disinfected effluent. Increased removal efficiencies, resulting from the implementation of pilot study recommendations, are expected in the full-scale marsh treatment facility currently in operation at Port Perry, Ontario.

ABSTRACT FORM

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KEY WORDS: Grit Removal, Sewage Treatment, Hydrocyclone, Toxic Contaminants.

Title: A Low Pressure Hydrocyclone for Use in Sewage Treatment

Abstract:

The objective of this project is to explore the possible use, in sewage treatment, of a new form of hydrocyclone, which can be operated at very low pressure differentials due to recovery of kinetic energy. While the major emphasis in the project is on efficient removal of fine grit there is also the possibility of using such a system for removal of faster settling organics thus replacing some primary clarification.

Rather than using designs of hydrocyclone similar to those used in other industries, it was decided that a special design should be developed to fit the special needs of the sanitary treatment process. The unit should have a large enough capacity to avoid installations with large banks of units, should have large enough clearances to avoid blockages, should be able to remove over 90% of 200 mesh sand particles and should be short enough to fit into a building with modest headroom.

The final design of hydrocyclone made to fit these needs with estimated hydraulic capacity and separating performance based on tests of similar smaller units is as shown below:

Dimensions

Barrel diameter	25 inches or 63 1/2 cms
Piping size	6 inches or 15 1/4 cms
Length	7 feet or 2 1/8 meters

Performance at 3 meters pressure differential
Flow 445 USgpm or 28 litres/second
Grit size removable at 50% efficiency 35 microns
Overflow rate 15 USgpm/sq.ft. or
(Clarifier Equivalent) 10.5 litres/sq.m. second

The predicted overflow rate is roughly 1/10 that used for design of grit channels and 25 times that of most primary clarifiers.

The research plan involves preliminary testing on controlled media at the University to evaluate flow and solids removal prior to installation in the field. The arrangement for this laboratory testing is almost completed and the results will be presented. A discussion of the nature of hydrocyclone and how specially designed units might be used in treatment of municipal and industrial effluents will also be included in the presentation.

ABSTRACT FORM

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KEY WORDS: Water Quality, Upper Humber River, Effects, Land Development.

Title: The Effects of Rural and Suburban Development on Surface Water Quality in Five Selected Subwatersheds on the Upper Humber River.

Abstract:

Previous research on the Upper Humber River indicated a combination of diffuse and point-source inputs were responsible for the observed widespread water quality degradation. The present study was conducted to assess in greater detail the relative pollutant contributions from five of the most predominant land use types within the watershed: suburban construction, agricultural row crops, livestock access, streambank erosion and undisturbed forest. The five study subwatersheds, ranging in size from 2.6 to 21.9ha were all located in the northwestern portion of the Humber River watershed. Surface water samples, under dry, wet and spring melt conditions, were collected at stations immediately upstream and downstream of each land use area, eliminating as much as possible any extraneous inputs. Bed sediment and soil samples were also collected on occasion and bed load samplers and off-stream sediment traps installed. Preliminary results indicate severe microbiological pollution occurring through the livestock subwatershed under all weather conditions. With one exception, fecal coliform densities ranged from approximately 200 to 500,000 counts/100ml during dry weather and FC concentrations in downstream bed sediments exceeded 4500 counts/gm sediment. Suprisingly high FC concentrations were also noted within the heavily forested "Control" subwatershed; possible sources are suggested. Concentrations of chemical parameters generally appeared low within all subwatersheds under dry weather conditions. Spring melt and wet weather data are currently being analysed. On the basis of hydrologic and precipitation data, annual parameter loadings are estimated for each study subwatershed and the results generalized to the entire Upper Humber River basin.

ABSTRACT FORM

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KEY WORDS: Humber River, Sediment, Bacteria, Water Quality, Black Creek.

Title: Humber River/Black Creek: Detailed Bacteriological Water Quality Study Examining the Impact of Sediment and Survival Times.

Abstract:

Studies to assess the effect of sediment resuspension upon bacterial loading of the water column were carried out at six sites along the upper and lower Humber River and Black Creek. Bacterial contribution from sediment was measured during dry weather (before and after mechanical agitation of the sediment); wet weather; and intermediate periods within two days after a rainfall. The results showed that during dry weather, at locations with consistently high point source bacterial loadings, samples taken from the water column after mechanical sediment agitation exhibited higher fecal coliform and *Escherichia coli* counts than samples taken before agitation. During wet weather, bacterial densities were usually observed to be higher than those induced by dry weather sediment agitation. This suggests that localized sediment resuspension is only one of a number of sources of bacterial pollution during storm events.

The survival rates of water quality indicator bacteria were also monitored to determine their response to the Humber River environment. Bacterial survival was found to be somewhat influenced by site-specific factors such as temperature and nutrient input For example, *E. coli* exhibited a 80 to 98% die-off rate within 24 hours at sites impacted upon by sewers, while a greater than 99% die-off rate was noted as sites not receiving nutrient enriched effluents. *Streptococcus faecalis* exhibited die-off rates similar to *E. coli* at most of the sites, whereas *S. faecium* survived somewhat longer. All three indicators survived better when the water temperature was lower than 10°C. *Streptococcus bovis* was found to exhibit rapid die-off in surface waters, i.e. greater than 99% in 24 hours.

ABSTRACT FORM

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KEY WORDS: Aquatic Plant Harvesting, Water Quality, Phosphorus Control, Nitrogen Control, Orangeville Reservoir, Credit River.

Title: Feasibility of Plant Harvesting in Water Quality Amerlioration and Phosphorus Management in Shallow Impoundment.

Abstract:

In a survey of southern Ontario reservoirs, eutrophication, as indicated by aquatic weed proliferation and/or algal blooms, was reported as a major management problem in over 80% of the impoundments. Aquatic plant harvesting may be useful in nutrient management in the reservoirs. In shallow impoundments where macrophyte biomass is high relative to the total volume of water, long-term harvesting, combined with control of nutrient sources, may effectively reduce loadings to downstream waters.

The Orangeville Reservoir, located at the headwaters of the Credit River, is highly eutrophic and contains heavy growth of aquatic macrophytes (Myriophylum spp.). The Credit Valley Conservation Authority wishes to maintain or improve water quality and to improve the recreational potential of the reservoir. To this end, a mechanical plant harvesting program was initiated in 1984. This study evaluates the harvesting program and its potential for water quality improvement in Orangeville Reservoir.

Based on an estimated input-output budget for phosphorus and nitrogen in a preliminary, the reservoir was found to act as a nutrient sink. The major storage compartment for both nitrogen and phosphorus was the highly organic sediments. Net phosphorus retention by aquatic vegetation was small; therefore, it is unlikely that plant harvesting will reduce phosphorus concentrations in the water. This was attributed to most of the phosphorus used by plants being obtained from the sediments. There was no indication of phosphorus release during winter die-off, suggesting that phosphorus tied up in the plants is returned to the sediments. On the other hand, up to 55% of total nitrogen requirements of plants appeared to be met from the water column. Thus, harvesting represents a potentially effective method of nitrogen control.

The monitoring program has been expanded and is being continued through one full year (1986) using more intensive water quality sampling and stream flow measurements to refine the nutrient budgets and to determine harvesting optimality in biomass and nutrient removal in the reservoir. The 1986 program will be complete in December 1986, and will be reported in early 1987.

ABSTRACT FORM

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Project No.: 249RR Liaison Officer : D. Persaud Phone: 323-4926

KEY WORDS: Bioassay, Sediment Disposal, Dredging, Water Quality.

Title: Two Bioassays for the Rapid Determination of the Effects of Dredged Sediment Disposal on Primary Production and Phosphorus Kinetics in Open Waters.

Abstract:

The open water disposal of dredged lake sediments can have potential toxic effects on the primary production in the receiving waters. In addition, the availability of nutrients and their cycling can be greatly affected. To date studies of dredgeate toxicity have examined only the effects on photosynthesis and have used only the sediment elutriates to assess toxicity. We now present two bioassays that (1) allow the determination of toxic effects of whole sediments on primary production, as opposed to sediment elutriates or extracts, and (2) allow determination of the effects of whole sediments and elutriates on phosphorus cycling.

The effects of Lake Ontario sediments on the primary production and phosphorus kinetics of epilimnetic phytoplankton assemblages were investigated. Sediment toxicity was assessed using sediment elutriates and whole sediments. The effects of both, on primary production, were measured using the incorporation of ^{14}C, into DMSO extractable compounds, over a range of irradiances. Elutriates prepared from polluted (Niagara River Mouth) and unpolluted (Mid Lake) sediments failed to show any toxic effect at a 10% (v/v) dosage, but whole sediment depressed the maximal photosynthetic rate (Pmax) by up to 70%.

The effects of sediment disposal on phosphorus cycling were assessed using $^{32}P\text{-}PO_4$ uptake kinetics. Phosphate turnover time was found to increase in a linear fashion with elutriate dosage. This effect was much greater with the Mid Lake elutriates. The addition of whole sediment caused much greater increases in turnover time than was seen with elutriates. The addition of heat killed sediment caused increases in turnover time lower than those shown by the lutriates.

The observed effects are best explained by the high concentrations of phosphorus and toxic chemicals that are present in the sediments but not extracted during the elutriation process. The high concentration of bacteria in the sediment and its physicochemical properties of sediments may plan an important role. These bioassays can be used to rapidly assess the potential toxic effects of dredged sediments, before disposal in open water.

ABSTRACT FORM

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KEY WORDS: Water Quality, Thames River, Toxic Contaminants, Phosphorus.

Title: Stochastic Estimation of Ambient Water Quality in the Thames River.

Abstract:

Quantifying the variations in water quality parameters is essential to developing objective policy for the management and control of toxic contaminants in Ontario streams. In this regard, research into the probability and stochastic features of phosphorous and suspended sediment concentrations in the Thames river has been performed. Mathematical models describing these features have been developed for monthly water quality events. Investigation in the probability behaviour of these events reveal that the governing probability distribution was not fixed for all months, but would change on a monthly basis. These distributions were also observed to be strongly non-Gaussian. The probability density functions were described using a five parameter polynomial expressions. This model successfully preserved the key moments (mean, variance, skewness, and kurtosis) of the historic water data.

Stochastic models for the phosphorous and suspended sediment concentrations were developed using the ARIMA process. Since this family of processes require that the underlying distributions for monthly events be Gaussian and time-invariant, novel transformations methods were developed for mapping monthly water quality data from its parent distribution to a N(0,1) distribution, for all months. The model constructed for the transformed monthly phosphorous variable as an ARIMA [1,1,0], with an autoregressive parameter estimate $\emptyset_1$ of -0.546. Transformed suspended sediment data was adequately described using a white noise ARIMA [0,0,0] model.

The modeling methodology developed in this research provides a solid framework for modeling water quality data from various streams. These data are likely to be non-Gaussian and represented by distributions that change monthly. The devised transformation guarantees that the probability distribution of the observed series is incorporated in the model. Hence synthetic water quality events generated using these models are bound to reproduce the complex non-Gaussian time-varying probability distributions, while representing the serial relationship between consecutive monthly events. This methodology also allows stochastic models to be developed for streams with substantial missing values, without having to make any assumptions about the character of the missing values, and thus provides a rational basic for "filling-in" missing values in the large set of historic record kept by the Ministry of the Environment.

ABSTRACT FORM

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KEY WORDS: Ottawa River, Nuclear Spill, Contingency Model.

Title: Ottawa River Nuclear Spill Contingency Model Development - Phase II

Abstract:

The purpose of the Ottawa River spill model development is to allow contingency planning in the case of a nuclear (probably tritium) spill from the Rolphton nuclear power demonstration (NPD) facility. A model which stimulates the two-dimensional - downstream and cross-stream - flow of pollutant already exists in the form of the FORTRAN 77 program TWODIFIN. The purpose of the Phase II Study is to extend this program.

As part of the Phase II Study, a one-dimensional version of the spill model has been developed and implemented in the computer program ONEDIFIN. This is a one-dimensional model - that is, it treats the river as a one-dimensional line and thus assumes complete lateral mixing of pollutant - that can be used to speed up calculations when the pollutant is laterally well-mixed. It is a multiple-source model, so that it can handle simultaneous spills from different locations, and it allows for first-order decay of the radioactive material.

Another major part of the Phase II Study was to interface the one- and two-dimensional programs. In such a hybrid program, the two-dimensional model would be used only for the portion of river that is not laterally well-mixed. Elsewhere, the one-dimensional model would be used, increasing the speed and efficiency of the calculations. This program has been developed and exists in single- and multiple-source versions - ONETWO and OTMULT, respectively.

Along with the main modelling portions, the study also involved the development of computer graphics and other programs to make the model interactive and easy to use. This is proceeding and it is hoped that the graphics will play a major role in helping to analyze and deal with potential spills. Also, model calibration is being performed using field data from the 1981 tritium spill from the Rolphton NPD.

ABSTRACT FORM

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Project No.: 243PL Liaison Officer : K. Brown Phone: 274-6710

KEY WORDS: Phosphorus Removal, Lakeview WPCP, Sludge.

Title: Experiment for Biological Phosphorus Removal at Lakeview WPCP

Abstract:

The Phoredox process, a biological phosphorus removal process, has many potential advantages when it is adapted to an existing conventional activated sludge plant. Major advantages include biological removal of phosphorus and improved sludge handling. For successful operation of the process, the wastewater must have adequate organic strength and suitable amount of phosphorus. The Lakeview WPCP has wastewater meeting all these required characteristics.

The purpose of the experiment is to investigate the effect of introduction of the Phoredox process to the existing WPCP on phosphorus chemical reduction, solids handling and plant operation.

The experiment was conducted in the first extension module of the Lakeview WPCP which consists of two equally sized trains of aeration tank and final settling tank. One train was used for the experiment while the other was used for the control.

The experiment consists of three phases: Phase 1 is an operation of the test train without chemical addition for phosphorus removal. The operation is to wash out all residual chemicals and provides the sludge for biological phosphorus removal process. Phase 2 is an introduction of a "pseudo" anaerobic zone in the first pass of the aeration tank and examines the effect of minimum air supply sufficiently for mixing only on the removal of phosphorus and plant operation. Phase 3 is an operation of the Phoredox process and examines the effect of the process on operating cost savings and plant operation.

Results of the Phase 2 experiment indicate that the test train with a "pseudo" anaerobic zone in the aeration tank can achieve an effluent phosphorus concentration of 1 mg/l or less with approximately 50% less chemicals. The system operation in terms of BOD loading rate, aeration time, and effluent quality did not have noticable difference in comparison with that of the control.

Phase 3 experiment is scheduled to start up this fall.

ABSTRACT FORM

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Project No.: 264RR Liaison Officer : K. Nicholls Phone: 235-5810

KEY WORDS: Algae, Heart Lake, Pollution Control.

Title: A Method for Prevention of Nuisance Blue-Green Algal Blooms

Abstract:

High nutrient loading leads to blue-green algal blooms which are often characterized by surface scums. Not only are the scums aesthetically unpleasant but oxygen depletion may follow the collapse of the bloom as the algae decay. This reduction in the recreational value of eutrohpic waters is important in regions with relatively few waters - and these regions often occur near large population centers.

Many reservoirs in southern Ontario are eutrophic and receive nutrients from non-point sources. In cases where nutrient diversion is impractical, a viable alternative is in situ treatment of symptoms. An experiment at Heart Lake, an eutrophic lake near Brampton, Ontario, tested the efficacy of adding hydrated lime ($Ca(OH)_2$) to control the growth of blue-green algae in enclosures. It was hypothesized that blue-green algal growth is prevented by (1) higher free CO_2 levels caused by dissolution of lime, (2) flocculation of algal cells and (3) reduction in total P by flocculation of particulate P, adsorption of P onto lime particles and formation and precipitation of hydroxyaptite. Preliminary results show that flocculation of algae occurred upon addition of lime and that algal population levels remained low.

ABSTRACT FORM

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KEY WORDS: Bioaccumulation, Mercury, Fish, Lake Vernon.

Title: Bioaccumulation of Mercury in Benthic Invertebrates from Non-Polluted Lakes.

Abstract:

High concentrations of mercury are found in fish from several lakes far from point source pollution. Factors regulating mercury uptake in fish seem to be multiple and are not clearly understood at present. Principal routes for mercury are assumed to be directly from the water or through their diet. The importance of benthic invertebrates, a base food item for several fish, has generally been overlooked. Moreover, bioturbation of sediment could be of significant importance in the mercury process. Our study was designed to evaluate the relevance of invertebrates for mercury cycling. First, a field study was undertaken. Bioaccumulation of mercury in benthic invertebrates from Lake Vernon (where fish have high levels of mercury) and Peninsula Lake (where fish have a lower level of mercury) were investigated. Lakes were sampled at several sites monthly between June-October, 1986. Mercury data on several groups of invertebrates were collected. Abundance and biomass of invertebrates were estimated in order to evaluate the total quantity of mercury available to the fish. In the second year of the project (1987), we will determine, in the laboratory, the influence of invertebrate density on the release of mercury from sediment. Monitoring of the bioaccumulation of mercury through the life cycle of organisms is also planned. Sampling design and preliminary results on invertebrate mercury will be presented.

ABSTRACT FORM

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KEY WORDS: Contaminant Fate, Arsenic, Surface Water, Sediment.

Title: Modelling the Fate of Arsenic in Natural Waters and Sediments

Abstract:

A family of models has been developed by Mackay and co-workers in order to predict the fate of contaminants in the aquatic environment by means of their chemical characteristics and the general limnological/hydrological characteristics of the receiving waters. The models, which use the chemical property of fugacity as a surrogate for concentration, have been successfully applied to describe the behaviour of organic compounds in evaluative and real environments. In this study we apply the fugacity model to inorganic contaminants in real environments. Arsenic was selected as the first substance on which to test the model because of its ubiquity as a contaminant in mining and mineral processing operations in Ontario.

To develop a preliminary model describing the behaviour of arsenic within a lake, experiments were conducted at the Chalk River Nuclear Laboratory (C.R.N.L.) of Atomic Energy of Canada Limited. The experiments involved introducing ^{74}As, a pentavalent arsenic acid, (the pentavalent state being that expected in oxygenated waters) into enclosed columns of water or limnocorrals, in Perch Lake on the C.R.N.L. property. The columns were 1 m in diameter, approximately 2 m high and open to the sediments.

The model developed to describe the distribution and movement of ^{74}As in this system uses four compartments: water, suspended particulates, sediments and fish. The loss rate of ^{74}As from the water compartment was first order with time, with 95% of the ^{74}As falling to the sediment. Sedimentation rates were obtained from sediment traps deployed in each of the four limnocorrals. Uptake of ^{74}As by fish in two of the limnocorrals, was also first order and depuration occurred rapidly (within 24 hours). Uptake by the fish accounted for a very low proportion of the total ^{74}As in the limnocorrals.

The fugacity model provides a relatively simple mathematical tool for describing the behaviour of ^{74}As in experimental microcosms such as limnocorrals. This model is also being applied to a natural system that has been subject to long-term arsenic contamination, the Moira River system in Eastern Ontario. In addition, the application of the model to other contaminants will be described.

ABSTRACT FORM

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Project No.: 192PL & 251RR Liaison Officer : D. Rokosh Phone: 235-5787

KEY WORDS: Cancer in Fish, Neoplastic Disease, Feral Fish, Effects.

Title: Pathogenesis of Neoplastic Diseases Afflicting Feral Fish

Abstract:

White suckers (Catostomus commersoni) and brown bullheads (Ictalurus nebulosus) from Hamilton harbour exhibit increased rates of liver and skin cancer; their pathogenesis and etiology are unknown. Cancer development is a long process, through many precancerous intermediate stages which can be influenced by environmental factors such as toxicity, infectious diseases, parasites, malnutrition, and viruses. Investigation various pathological changes in affected fish will facilitate a critical evaluation of the widely held hypothesis that chemical pollutants in the sediments may be solely or partly responsible for the observed tumors. This approach involves multifactoral epidemiology of affected and unaffected fish populations by characterization of possible modifying factors, testing for associations with cancer rates. Enzymology and histopathology studies of liver and skin are underway, to initially investigate some intermediate stages and possible modifying factors. Also, we are attempting to find ways of detecting precancerous changes caused specifically by carcinogens.

It is necessary to ascertain if chemicals are totally or even partly responsible for the observed tumors, and how they cause the cancers, if responsible decisions are to be made regarding human health implications.

ABSTRACT FORM

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Project No.: 238RR Liaison Officer : W. Subock Phone: 323-4884

KEY WORDS: Water Use, Kraft Mills, Water Pollution.

Title: The Use of Water in Ontario Kraft Mills

Abstract:

The application of new technology to pulp mills around the world has sharply reduced quantities of liquid effluent. The reduced volumes simplify the task of pollution control. An obvious question, therefore, is the practicality of modifying the process at Ontario kraft mills, with one of the benefits - the further reduction of stream pollution.

The study will provide an overview on how water is used and conserved in Ontario kraft mills and how the various processing installations effect the quality of the effluent.

ABSTRACT FORM

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KEY WORDS: Water Supply, Computer Control, Sewage.

Title: Feasibility of Computer-based Centralized Control Systems for Water Supply and Sewerage Facilities.

Abstract:

The Ministry is responsible for the operation of over four hundred and fifty water supply and sewage facilities throughout the Province.

The authors of this paper believe that it is timely to review these facilities to assess the viability of employing modern computer based Supervisory Control and Data Acquisition Systems (SCADA) to replace some of the operations now performed manually, and to provide a high level of remote control and management. In our experience these systems are both cost effective, and capable of providing a high level of performance, including improving system security.

District Centres are the focal points of the concept proposed and, as such, they will be able to control and monitor all of the remote facilities in the district served. At present each of these facilities has varying degrees of unattended automatic operation. Under this concept with solid state controls, the present system will be enhanced in order to provide completely automatic control and data reporting to the District Centre.

The MOE Regional offices will have access to data from all of the District Centres under its jurisdiction.

Another major function of the Ministry, namely performance monitoring of both provincial and non-Ministry operated water and sewage facilities, might more easily be achieved using a centralized data management system. As municipally owned plants acquire more sophisticated equipment, data from this equipment could readily be transmitted to a Ministry data management centre both for monitoring and record purposes.

ABSTRACT FORM

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KEY WORDS: Sewage Treatment, Marsh Treatment.

Title: The Evaluation of Native Marsh Plant Species for the Treatment of Domestic Sewage.

Abstract:

Research is presently underway to compare the efficiency of three aquatic plant species for their ability to treat domestic sewage in an artificial marsh environment. The species being evaluated are: Typha angustiofolia (narrow leaf cattail), Scirpus validus (bulrush) and Phragmites australis (common reed). T. angustiofolia is presently being evaluated in a full-scale marsh treatment system at Port Perry, Ontario. The other two species, S. validus and P. australis have not been evaluated in Canada and little use of them has been made elsewhere for wastewater treatment.

Monoculture stands of each species have been established in separate steel enclosures. Each cell measures 15m x 1.5m, providing a length to width ratio of 10:1. Pre-treated sewage of a known quality is applied to each cell. A fourth cell is also provided as a control. The effluent from each cell will be sampled bi-weekly until November, and then monthly through the winter period. Standard wastewater parameters including D.O., BOD, S.S., H_2S. TP and TN will be measured. Evaluation will be continued in the second year.

Sampling of the establishing marsh plant cells will commence in August, 1986. Treatment will be compared under various loading and depth conditions to determine optimum culture practice for each species. Results obtained will be compared to the adjacent, full-scale operating cattail marsh and design criteria developed for scale-up of successful species.

ABSTRACT FORM

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KEY WORDS: Wastewater, Sewage Treatment, UV-Disinfection.

Title: UV Light Disinfection of Wastewater: Factors Affecting its Performance

Abstract:

A full scale gravity flow UV system was used to study the effect of wastewater quality and the performance of the equipment on the parameters used to measure UV disinfection.

A soluble UV absorbing compound was added to the wastewater to determine the effect of UV transmission on the number of total and fecal coliforms before and after photoreactivation.

Primary and secondary solids were added to the effluent to ascertain the effect of solids on the number of total and fecal coliforms before and after photo-reactivation.

An Escherichia coli with a genetic marker was added to the effluent before and after the UV units. These irradiated and non-irradiated bacteria were observed in the receiving stream for 2 hours to determine whether photoreactivation took place. Samples were taken in the river just below the outfall of the WWTP. These bottled samples were placed in the river as a control for the in-situ study.

There was no correlation between the measurements of the sunlight at a wavelength of 365 nm and the degree of photoreactivation over a period of 14 months.

The lamp and quartz sleeve which were used in the UV system were tested for UV output versus temperature.

The UV light output of the lamps was observed over a time period of 28,392 hours.

The contact time of the UV units was determined for a series of flow rates.

As a better indication of effluent quality somatic and f-specific phages which are resistant to disinfection were enumerated before and after UV irradiation and chlorination. The numbers of phages were correlated with the presence of fecal and total coliforms, E. coli, fecal streptocci and Pseudomonas.

ABSTRACT FORM

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KEY WORDS: Biomonitoring, Mussels, Toxic Contaminants, Lake St. Clair.

Title: Validation of the Use of Freshwater Mussels as a Biological Monitor of Toxic Contamination

Abstract:

Experiments were undertaken in the Lake St. Clair region to obtain greater knowledge of the uptake kinetics of organic contaminants (represented by hexachlorobenzene, octachlorostyreen, and PCBs) by freshwater mussels. The mussels were shown to obtain the majority of their body burden from the water column as opposed to the sediment phase as indicated by the lack of significant differences in contaminant concentration between mussels placed in monitored conditions.

Four unionid species from a site in Lake St. Clair with high contaminant loadings were transferred to 1400 l tanks to examine the loss rate of selected contaminants. Over a fifty-four day period there was not significant loss of octachlorostyrene, while the four species showed on average a 22 percent decrease in hexachlorobenzene loadings. The results will be compared with field studies involving the transfer of mussels from toxicant rich to uncontaminated sites. The slow loss of contaminants contrasts with their rapid uptake, as previous work has suggested that body burdens reach an asymptote after seventeen days of exposure.

By examining other aquatic invertebrate fauna, it can be determined whether the contaminant loadings found in the dominant mussel, *Lampsilis radiata siliquoidea*, are indicative of other organisms. Comparison of six unionid species from sites on Lake St. Clair indicated little difference in contaminant levels amongst the species. Analysis in progress will extend the comparison to oligochaets, mayflies, and caddisflies, and determine the effect of age and sex on the toxicant loadings in individuals.

ABSTRACT FORM

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KEY WORDS: Agricultural Drainage, Tile Drainage, Hydrologic Model.

Title: The Effects of Tile Drainage and Open Ditches on Peak Flows and Dry Weather Flows

Abstract:

The project is scheduled for a three-year period and has been designed to assess the effects of tile drainage and open ditches on peak flows and dry weather flows with particular application to Ontario. This study involves (I) the development, calibration and testing of a continuous, physically-based, hydrologic simulation model for tile-drained agricultural fields and basins; (II) instrumentation of tile-drained fields in the South Nation River Basin; and (III) statistical analysis of (a) historical data from ditch and tile-drained fields and basins in the South Nation River Basin and elsewhere, and (b) simulated discharges generated by the model developed in (I) above, both on a peak flow and a dry weather flow basis.

The project is presently 10 months into year 2 of its three-year schedule. A worldwide literature survey has resulted in the production of an annotated bibliography for the hydrology of agricultural drainage. Over 400 abstracts covering the period 1970-84 have been collected, catalogued and entered in a database using dBASE III. It is available both in hard copy and on IBM-PC compatible disks.

A physically-based hydrologic simulation model for tile-drained agricultural fields has been developed for the simulation of tile drain discharge under single rainfall events. The model is now being tested and calibrated. Instrumentation has been installed in two tile-drained fields to collect rainfall and discharge data for 1986. Additionally an extensive field program has been initiated to determine the physical characteristics of the soil to assist in the calibration of the TILE model.

ABSTRACT FORM

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KEY WORDS: Biomonitoring, Organic Contaminants, St. Clair River, Great Lakes, Water Quality.

Title: The Biological Monitoring of Organic Contaminants in the St. Clair River and Lake St. Clair

Abstract:

A research program was started in June 1986 to assess the usefulness of selected species as monitors of organic contaminants in the Lake St. Clair and St. Clair River aquatic system. Most of the research effort to date has concentrated on caging experiments with the fresh water mussel Elliptio complanata. Relatively contaminant-free individuals of this species were collected from Balsam Lake, Ontario and caged individuals deployed in the St. Clair River off of Walpole Island, in the Chenal Ecarte, Wallaceburg and in Lake St Clair near the mouth of the Thames River. Exposed individuals were analyzed for QCB, HCB, OCS and PCBs (total and Aroclors 1242, 1254, 1260). Results are presently available for 6 week exposures at the Walpole and Chenal Ecart sites and 3 week exposures at the Wallaceburg and Thames sites. At Walpole and Chenal Ecarte, QCB and HCB showed a significant accumulation after 3 weeks exposure with no additional accumulation after an additional 3 weeks. A significant accumulation of OCS was found at these two sites after 3 weeks and a further linear accumulation after an additional 3 weeks exposure. Mussels exposed at Wallaceburg showed a significant accumulation of OCS and HCB but no detectable accumulation of QCB after 3 weeks. No significant differences in the accumulated levels of organic contaminants were found between mussels exposed at different depths in the water column. No significant accumulation of QCNB, HCB, OCS and total PCBs was detected in mussels exposed for 3 weeks at the Thames site. Total PCBs accumulation at the remaining three sites was highly variable among individuals but there was evidence for significant accumulation after 6 weeks exposure Laboratory experiments are presently being designed to study the uptake of selected organic contaminants by E. complanata. These experiments will provide information to compare with data from the field caging study.

Information on the levels of organic contaminants is also being collected on ducks and muskrats from Walpole Island, from sediment and benthic invertebrates in Lake St. Clair and from the adult stages of aquatic insects. Preliminary exposure experiments with caged minnows have also been conducted in the St. Clair River and Lake St. Clair. These studies will continue into the fall of 1986 and will be resumed in the spring of 1987. An initial survey of contaminant levels in aquatic macrophytes will be carried out in the spring of 1987. Data on biota contaminant levels will be used as input for the U.S. EPA WASTOX model to model the fate of organic contaminants as they move through different trophic levels. The WASTOX model is presently being tested with data from the literature.

ABSTRACT FORM

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Project No.: 180PL Liaison Officer : J. Dart Phone: 323-4876

KEY WORDS: Defluoridation, Groundwater, Amabelle Township.

Title: Defluoridation of Amabelle Township Groundwater

Abstract:

A study of groundwater defluoridation was carried out in August 1985. Two defluoridation processes were selected for evaluation after an intensive literature review. These were:

1. Activated Alumina
2. Reverse Osmosis

Activated Alumina is currently in use in the United States. However, very little data is available on the quality and quantity of regenerant waste produced by the process. Two types of regenerant were evaluated:

1. 1% NaOH Solution
2. Hanfloc (with an equivalent caustic strength to 1% NaOH).

Rapid advances have been made in membrane technology over the past ten years. Reverse Osmosis was evaluated to assess its degree of efficiency and throughput capacity.

The results of both pilot units will be presented, with cost estimates and operational requirements for treating the Amabelle Township ground water.

ABSTRACT FORM

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KEY WORDS: Port Dover, Sewage Treatment, Activated Sludge, Aeration Devices, Tree Farm, Lagoons, Effluent.

Title: Pre-Feasibility Study on Expansion and Upgrading of Port Dover Sewage Treatment Plant

Abstract:

The existing Port Dover Water Pollution Control Plant is a primary plant with phosphorus removal and has been subject to a number of operating problems during the last few years. A study was commissioned to review these problems and evaluate a number of options for expanding and upgrading the plant to provide secondary treatment.

The following options were considered:

- Conventional Activated Sludge
- Rotating Biological Contractors
- Biological Aerated Filters
- Extended Aeration, and
- Tree Farm

Two of the options considered are innovative concepts which have not been used in plants in Canada to date. The first is the biological aerated filter, marketed by Envirotech. It consists of a steel tank filled with fired clay media. Effluent is introduced at the top of the media, the upper section of which accomplishes biological treatment, and the lower section of which acts as a clarifier. The major advantage of this system is the low space requirement, and the fact that no secondary clarifiers are required, thus saving considerable capital cost.

The tree farm design involves storing sewage in a lagoon system and spray irrigating a tree farm with the effluent. In this manner, nutrients in the effluent enhance growth of the trees, and evapotranspiration from the leaf surfaces disposes of all of the effluent produced. This system has the added benefit of producing a valuable by-product, as the fast growing poplar and willow in the tree farm could be harvested as an energy crop every few years.

Capital and operating costs, and benefits of each system are outlined and a present worth analysis covering a 20-year period is performed as part of the analysis.

ABSTRACT FORM

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Project No.: 197RR Liaison Officer : P. Dillon Phone: (705) 766-2412

KEY WORDS: Acid Rain, Snow Melt, Effects.

Title: Acid Rain and Snow Melt Events and the Resulting Stress on Fish

Abstract:

The purpose of this study was to determine whether the waters of Heney Lake, Ontario, became toxic to fishes, both endemic and introduced during episodic pH depressions. Advanced notice of an acid precipitation event or a snow melt was provided by Atmospheric Environment Service, so as to make possible the monitoring of water quality and fish health before the event commenced. Rainbow trout and white suckers were held in cages in the outlets of lakes Heney (test) and Harp (control). With the commencement of the melt and pH depression, fish were sampled every 4 hrs. for ionic composition of plasma and muscle.

The snow melt of February 19-23, 1985, reduced the pH of the outlet stream to the range of 4.3 to 4.0, with alkalinities -1.9, to -11.8 ueq. L^{-1}, and resulted in a decline in plasma Na from 130 to 105 meqL^{-1} and Cl from 108 to 82 meq L^{-1}, in rainbow trout, losses of 20 and 24%. Concurrent with the loss of blood and muscle ions, gill Al conc. increased from 10 to 250 ug.g^{-1} dry wt.

The snow melt of April 11-13, 1985, depressed the outlet stream pH into the range of 4.7 to 4.1 and induced a similar ionic stress in rainbow trout, with plasma Na conc. declining from 148 to 85 meq.L^{-1} over 42 hrs. The control fish (heney L. outlet pH 5.75) showed no significant decline in muscle and plasma ion concentration over 38 hrs.

The last snow melt of 1985 (April 27-29) was monitored with white suckers held in Heney L. outlet, pH 4.3 to 5.0, and Harp L. outlet, pH 6.9. Heney-held fish showed a small but significant decline in muscle ion conc., and small but not significant declines in plasma ion conc. Harp-held controls did not change significantly.

The snow melt of March 28-29, 1986 was monitored in the outlet streams of lakes Grindstone and Little Wren using rainbow trout. Data analysis is in progress.

The snow melt of April 22-24, 1986 again induced physiological stress in rainbow trout held in Heney L. outlet, pH 5.25. Plasma Cl declined from 128 to 80 meq.$L.^{-1}$. In contrast to earlier studies, the trout held in Harp L. outlet also showed stress, with plasma Cl declining from 123 to 90 meq.L^{-1}.

The snow melt of May 7-8, 1986, was monitored with white suckers. These fish showed no significant decrease in concentration of plasma and muscle ions. Gill analyses are in progress.

ABSTRACT FORM

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KEY WORDS: Upper Humber River, Water Quality, TWAMS, Toronto Watershed.

Title: Upper Humber River Water Quality Study

Abstract:

During the course of the Toronto Area Watershed Management Strategy Study (TAWMS) it became apparent that violations of the Ontario Ministry of the Environment's Provincial Water Quality Objectives (PWQO) routinely occurred in the Humber River north of the Metropolitan Toronto boundary. This one year study was conducted to better identify and characterize the main sources of selected pollutant loadings within the predominantly rural Upper Humber River watershed. Grab samples, analyzed for both microbiological and chemical parameters, were collected during three dry event periods between June and December 1984 as well as intensive sampling during one storm event which occurred in late fall. Existing stream flow gauges were utilized and thirteen temporary staff gauges installed and stage-discharge curves established to allow estimation of instantaneous chemical loadings. Fecal coliform geometric mean densities during dry weather indicated water quality degradation throughout the Upper Humber watershed, even at stations relatively close to source. Dry weather concentrations of other parameters including TSS, TP, Cu, Pb, and Cd were also in exceedance of PWQO at stations throughout the study area. Exceedances were particularly frequent between the Towns of Bolton and Woodbridge. Identified point source inputs as well as stretches of severe streambank erosion and cattle access were all likely contributors to the observed parameter levels. The lowest dry weather concentrations generally occurred in December suggesting a strong seasonal influence. With some exceptions (notably Cu and Pb), parameter concentrations were greatest under wet weather conditions. Physiographic differences between subbasins, influencing both parameter concentrations and loadings during the storm event, were observed and are discussed in the report. The study concludes that water quality problems in the Upper Humber watershed, although not of the magnitude of those occurring in the lower Humber, cannot be discounted in the development of a water management strategy if PWQO are to be achieved.

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ABSTRACT FORM

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KEY WORDS: Ozone Treatment, Organic Contaminants, Drinking Water, Treatment Technologies.

Title: Ozone Treatment and Trace Organic Contaminants in Drinking Water - Future Research Directions

Abstract:

An in-depth literature review of the state of the art in the application of ozone in drinking water treatment was conducted. The review included a survey of the by-products resulting from the reaction of ozone with typical natural and man-made components of water; an examination of the implications of ozone reaction rates to the use of ozone for trace organic removal; an assessment of the effects of processes such as coagulation/sedimentation/filtration, adsorption, reverse osmosis and air -stripping on by-product removal/reduction; and a preliminary assessment of the health significance of ozonation by-products.

ABSTRACT FORM

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Project No.: 109RR Liaison Officer : W. Lewandowski Phone: 323-4984

KEY WORDS: Mine Tailings, Metals, Wastewater Treatment, Marsh Treatment, Bacteria.

Title: Effects of Metals from Mine Tailings on the Microflora of a Marsh Treatment System

Abstract:

Bacteria, isolated from a marsh treatment system on the site of a mine tailings basin, were assessed for heavy metal and antibiotic resistance. All isolates were found to be multiply antibiotic and heavy metal resistant. Klebsiella and Pseudomonas spp. demonstrated the highest levels of resistance to the antibiotics and metals tested. The fecal coliform group displayed similar resistance patterns, suggesting the presence of a common plasmid. Examination of the K. oxytoca marsh system isolate for the presence of plasmid DNA revealed six plasmids, ranging in size from 3×10^6 to 50×10^6 Da. The results of this study suggest that the presence of mine tailings in an aquatic environment may promote the development of antibiotic and heavy metal resistance among the microbial flora.

ABSTRACT FORM

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KEY WORDS: Epidemiology, Water Quality, Bacterial Pollution, Ontario Beaches.

Title: Epidemiological Study of Disease Incidence and Recreational Water Quality at Selected Conservation Areas in Southern Ontario

Abstract:

A prospective cohort study of swimming - related illness was conducted at six Southern Ontario freshwater beaches in the summer of 1983. Lake water samples collected at the beaches were analyzed for: heterotrophic plate count, total staphylococci, fecal coliforms, *Escherichia coli*, fecal streptococci, enterococci and *Pseudomonas aerouginosa*. A total of 6,653 swimmers, 574 waders and 1,193 nonswimmers were interviewed at the beaches. Results of the 8,420 telephone follow-up interviews showed that crude morbidity rates were 76.8 per 1,000 swimmers; 41.8 per 1,000 waders; and 19.3 per 1,000 nonswimmers. Swimmers and waders experienced respiratory illness most frequently, followed by gastrointentestinal ailments. Results of logistic regression models, where confounding variables were taken into consideration, suggested that the percentage of swimmers expected to experience gastrointestinal illness was 1.7% (± 2 x 0.2), 1.9% and 2.5% at counts of 100,200 and 1,000 fecal coliforms per 100 mL, respectively.

Logistic regression modeling of the currently used guidelines of 100 and 200 fecal coliforms per 100 mL of water was also carried out. The data showed that the Ontario guideline of 100 fecal coliforms was more effective (p = 0.0127) in the prediction of illness in swimmers than the 200 fecal coliform value (p = 0.2857).

ABSTRACT FORM

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KEY WORDS: Groundwater, Organic Contaminants, Volatilization.

Title: Volatilization Losses in Groundwater Monitoring of Organics in Low-Permeability Materials

Abstract:

The bias that may be introduced by volatilization of organic solutes from groundwater standing or entering monitoring wells or piezometers is evaluated. Previous studies showed that, for all but the most volatile organics, volatilization losses during sampling do not introduce unacceptable bias.

Standard screened piezometers, 2.5 cm to 10 cm diameter, are usually installed with a sand filter pack when groundwater in low-permeability materials is to be sampled. After flushing of the piezometer, ground-water must normally accumulate for hours to days before a volume sufficient for sampling is available. During this period the ground-water is exposed to the open atmosphere and volatilization can be expected to occur.

To evaluate this bias, laboratory simulations were conducted. The rate of volatilization of four, chlorinated, one- and two-carbon compounds were measured: a) from the water standing in the piezometer, and b) during the recovery of the formation water into the sand pack and screened interval of the piezometer.

The practicing hydrogeologist should be aware that these biases exist when comparing data from formations of widely different hydraulic conductivities. For the most accurate results, monitoring piezometers which are open to the atmosphere should not be used in formations of very low hydraulic conductivities to sample for groundwater for volatile compounds.

ABSTRACT FORM

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Project No.: 194PL Liaison Officer : J. Smith Phone: 323-5113

KEY WORDS: Exposure, Assessment, Organic Contaminants, Multi-media Pollution, Contaminant Fate.

Title: Multimedia Environmental and Human Exposure Assessment of Organic Contaminants.

Abstract:

Chemicals emitted into the environment are distributed through many media - air, soil, water, sediments, biota and man. Since it is impossible to monitor all media to all contaminants, mathematical models have proved useful for predicting the environmental and physiological fate of these compounds. In this project, we are continuing the development of fugacity-based environmental and pharmacokinetic models to describe the multimedia partitioning and pathways of pollutants. The models attempt to elucidate the routes of toxic organic compounds through the environment, into food, water and air, and the ultimate physiological distribution to tissues and organs in man.

The level IV unsteady state model describes situations of (i) time-varying emissions of pollutants, and (ii) contamination with subsequent recovery. The model has been reformulated using a novel numerical integration technique of the set of differential mass balance equations to provide a robust, simplified and comprehensive solution.

Correlations have been incorporated for air/water exchange processes, including wet and dry particle deposition and rain dissolution. Preliminary correlations for exposure through food and water ingestion are being developed. Validation is proceeding for compounds for which data is available. The major focus has been on PCBs for which there are comprehensive data.

A novel steady state pharmacokinetic model has been developed to simulate the physiological fate of organics in humans after prolonged continuous exposure by simultaneous oral, inhalation and dermal exposure. The model elucidates the contribution of each intake route to total body burden.

ABSTRACT FORM

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KEY WORDS: Sewage Treatment, Lagoons, Infiltration, Markdale.

Title: Treatment of Municipal Sewage Lagoon Effluent by Means of Rapid Infiltration at Markdale, Ontario

Abstract:

The expansion of municipal sewage treatment facilities for the Village of Markdale included a system of rapid infiltration basins. Consisting of eight rapid infiltration basins each 56.25 m x 6.0m average in size, the rapid infiltration system provides the "final" polishing of the sewage lagoon effluent before it reaches the Rocky Saugeen River up to 200 metres away. Thus, the seasonal discharge into the Rocky Saugeen River, a high quality stream, was discontinued.

Geological material which receives the sewage lagoon effluent consists of stony silty coarse gravel and sand of glaciofluvial origin. After moving through these subsurface environments, some of the effluent discharges into a partially wet cedar wood. It continues to move overland thereafter, where additional treatment is afforded involving various microbiological processes.

The rapid infiltration system went into full operation in late June, 1986. It is being operated under close supervision. An intensive monitoring program and data collection is underway with the aim of assessing various aspects involved.

- Optimal hydraulic loading of the system at various operating configurations of the basins and at different inundation/resting periods.
- Hydraulic response of the water table aquifer to the hydraulic loading.
- Clogging of basins and geological materials.
- Renovation of the sewage lagoon effluent while moving through the subsurface environments.
- "Final" polishing of the effluent involving various microbiological processes.
- Impact, if any, on water quality in the river.
- Operation of the system under severe winter conditions.

Some findings of this study will be presented at the forthcoming Technology Transfer Conference.

ABSTRACT FORM

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Project No.: 168PL Liaison Officer : J. Gasbarri Phone: 323-4437

KEY WORDS: Water Treatment, Trace Organics, Drinking Water, Activated Carbon, Great Lakes, Contaminant Removal.

Title: Pilot Testing for Organic Contaminant Removal from Drinking Water at Atikokan, Ontario

Abstract:

This paper describes the procedures used and results obtained from four (seasonal) pilot test runs on treatment of raw water from the Atikokan River in 1984 and 1985 for removal of colour. The processes studied were:

- coagulation and flocculation using alum and polyelectrolyte, followed by direct dual media filtration;
- ozonation followed by carbon adsorption;
- ozonation followed by coagulation and flocculation, and direct dual media filtration.

Process efficiencies, chemical dosages required and costs were compared.

The ozone/carbon adsorption process results in the highest treatment costs because of the low carbon bed life experienced. The other two processe were competitive with the advantage going to ozonation, followed by coagulation and flocculation, and direct dual media filtration on the basis of low chemical costs offsetting the increased power costs.

Also, sludge volumes form settled backwash water were reduced. On the basis of these pilot studies, a process design was developed for a 6,000 m^3/day (1.5 mgd) water treatment plant to serve the community.

The project was funded by the Ontario Ministry of the Environment under the auspices of the Research Advisory Committee.

ABSTRACT FORM

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KEY WORDS: Sulphur Cycle, Plastic Lake, Dorset, Impact.

Title: Contributions to the Understanding of the Sulphur Cycle in the Plastic Lake Watershed, Dorset, Ontario

Abstract:

The environmental impact of anthropogenic sulphur is both a regional and global concern. The nature of this impact depends in large part on the chemical responses of forest canopies and soils to sulphur deposition from the atmosphere. At present, these responses are still largely unknown. However, there is a complex array of processes that can affect dissolved (and gaseous) sulphur compounds as they pass through forest canopies and soils. Some important processes are biological redox cycling by plants and microbes, and adsorption - desorption of sulphate by hydrous iron and aluminum oxides. Oxygen and sulphur isotopic analyses of various sulphur species from the atmosphere, precipitation, throughfall, stemflow and soils, are useful for determining the relative importance of the chemical processes affecting them.

Our study area is a small subcatchment of the Plastic Lake watershed located near Dorset, Ontario. An ongoing intensive study of this region by the Ontario Ministry of the Environment is generating substantial data on anthropogenic acidification and the general cycling of sulphur and other elements. Our study involves a more detailed monitoring of the sulphur cycle through isotopic analyses. We are collecting water samples from precipitation, throughfall, stemflow, and soils, as well as a spring, stream, bog, and Plastic Lake on a weekly and/or monthly basis. We then analyze the sulphate concentration and its sulphur and oxygen isotopic composition. Preliminary results indicate a strong oxygen isotopic shift between precipitation sulphate (^{18}O 7%) and soil sulphate (^{18}O 8%). This may be the result of biological redox cycling in the soils, or absorption of atmospheric SO_2 by forest canopies and soils, or other processes. Sulphate in groundwaters (spring) and surface waters (bog, stream, lake) are similar in composition to the antecedent (?) soil sulphate (^{18}O 8%). Isotopic analyses of other sulphur species are not yet available.

ABSTRACT FORM

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KEY WORDS: Metal Uptake, Niagara River, Biomonitoring, Water Quality.

Title: Metal Uptake and Loss in Cladophora Glomerata in the Niagara River: Implications for Biomonitoring.

Abstract:

Biomonitoring, the use of organisms to provide information about environmental quality, is becoming an increasingly popular method for environmental assessment. Cladophora, a filamentous green alga has been proposed as a global biomonitor of water quality. In order to determine the rate of uptake and loss of heavy metals, Cladophora was transferred from a site of low contamination to one of high contamination in the Niagara River and vice versa. Within 72 hours, algal concentrations of lead and mercury decreased when placed in a "clean" site and increased when placed in a contaminated site. Lead and mercury concentrations in transferred Cladophora resembled the concentrations of undisturbed Cladophora after approximately one month. Algal cadmium concentrations exhibited less change upon transfer due to the small differences in cadmium concentrations among sites.

The concentration of cadmium, lead and mercury in water and Cladophora varied seasonally. High metal concentrations in the Niagara River were associated with storm events, suggesting that resuspension of contaminated sediments or urban runoff may increase metal concentrations in the water column. For lead and mercury, the metal concentration in filtered water samples was substantially less than nonfiltered samples, while filtered and nonfiltered cadmium samples were more similar in concentration. In general, the greatest fluctuations in metal concentration in water samples occurred at the sites of highest contamination, while sites of relatively low aqueous metal concentration showed less extreme fluctuations. These changes in metal concentration in the Niagara River were reflected in the metal concentration in Cladophora, suggesting that Cladophora is an effective biomonitor of water quality.

ABSTRACT FORM

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Project No.: 199RR Liaison Officer : K. Suns Phone: 235-5798

KEY WORDS: Bioaccumulation, Mercury, Fish, Lake Clear.

Title: Bioaccumulation of Mercury by Juvenile Yellow Perch

Abstract:

Larval and juvenile yellow perch were sampled for growth and mercury body burden from June until May of their first year of life in Clear, Dickie and Harp lakes. It is during these early life stages that abundance, biomass and consumption are highest. For this reason, the majority of incorporation of mercury into fish flesh is controlled by young of the year fish both as predators on zooplankton and benthos, and as prey to piscivorous fish. Therefore, an understanding of the pathways and rates of bioaccumulation by young fish is essential to the understanding of the intra-and inter-lake variation in sport fish mercury contamination.

Larval perch in all three lakes had approximately equivalent mercury concentrations, about 2.0-4.0 ppm. For their first 3 months of life they eat exclusively zooplankton and mercury concentration remained similar. By August-September, the juvenile perch in Dickie and Harp lakes switched to benthic feeding and the October mercury concentrations were 14.0 and 20.0 ppm respectively. The difference between the two lakes is probably because of higher consumption rates of the Harp Lake juvenile perch as predicted by the bioenergetic analysis. Mercury concentration in the Clear Lake juvenile perch remained in the 4.0-5.0 ppm range since they continued to feed on zooplankton and consumption rates were lower than in Dickie or Harp lakes. The significance of the respiration and consumption pathways of mercury bioaccumulation can be assessed, using a bioenergetics model, once the water, zooplankton and benthos data sets are complete.

SECTION C

LIQUID AND SOLID WASTE RESEARCH

ABSTRACT FORM

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Project No. : 191 PL Liaison Officer: W. Ng Phone: 323-5128

KEY WORDS : Refuse, Municipal Solid Waste, Pyrolysis, Emission Rate, Incineration.

Title: Assessment of a Prototype System For Pyrolysis of Refuse Derived Fuel

Abstract:

EFW Systems Incorporated have developed and constructed a prototype unit to pyrolyse refuse derived fuel (RDF), with the intent of using the pyrolysis gases as an engine fuel to generate electricity and as a source of process heat for the pyrolyser. An environmental and process assessment of the prototype unit has been made to determine potential advantages and disadvantages of the system in comparison to conventional municipal solid waste (MSW) incineration techniques.

The sampling and analytical program is briefly discussed, covering process operating conditions, emission components of interest, sampling and analytical methodologies and problems encountered. Data are presented to show the impact on air quality if pyrolysis gases were emitted directly to the atmosphere, and the potential problems for unit operators resulting from pyrolysis gas leakages. An approximate energy balance for the system shows that process modifications would be required to have pyrolysis gas available as an engine fuel.

ABSTRACT FORM

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Project No. : 234 RR Liaison Officer: P. DeAngelis Phone: 323-5130

KEY WORKDS : Municipal Waste, Gasification, Plasma Arc.

Title: Municipal Solid Waste Feasibility of Gasification with Plasma ARC

Abstract:

Resorption Canada Limited (RCL), in conjunction with Ontario Hydro Research Division and OBOE Engineering Limited, is conducting a feasibility study of the plasma gasification of Municipal Solid Waste (MSW), including operational experimentation within the RCL Plasma Research Facility in Ottawa, Ontario. The objectives of the study are to demonstrate the operational and environmental characteristics of the plasma gasification of MSW in order to increase the visibility and potential acceptability of the use of plasma technology in such an application.

This experimentation is expected to largely substantiate the postulated process characteristics of plasma gasification of MSW, the most salient of which include: a 4-5 fold increase in usable output energy compared to input electrical energy which represents a theoretical recovery of approximately 95% of the available energy in the input material, a product gas with a potential heating value of 300-350 BTU/scf, and a potential minimal requirement for environmental controls for the subsequent combustion of the product gas or the disposal of the virtually inert byproduct slag. The major benefits considered achievable through the plasma gasification of MSW are: more flexibility of potential operation since the output is a product gas; lower capital costs due to greater potential integration of the process equipment into an owner's existing facility; the minimization of undesirable pollution products in the product gas and the maximization of the energy recovered from the input material since both the operating temperature and the heat transfer rate are variable virtually at will; the complete breakdown of the input material and the production of smaller molecules which are inherently less hazardous; the processing of input material at any rate from next to nothing up to the maximum capacity of the system, all at the optimal operating point; the minimization of pollutants exhausted to the atmosphere since the material must first pass through two chemical reactions before being exhausted; and, a potential commercial market for the virtually inert byproduct slag.

Stage 1 of the project, which will determine the Higher Heating Value (HHV) of the product gas and the total process heat balance, commenced 1 April 1986. Stage 2, which will determine the environmental acceptability of the process and the subsequent combustion of the product gas is scheduled for commencement early in 1987 dependent on the results obtained through Stage 1. Project costs are being shared by the project participants, Plasma Energy Corporation of Raleigh, North Carolina and the Ontario Ministries of Energy and Environment.

ABSTRACT FORM

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KEY WORDS : Sewage Sludge, Compost, Fertilizer.

Title: Sewage Sludge Compost as Turf Fertilizer

Abstract:

The suitability of the Windsor composted fertilizer for Turf has been evaluated on home lawn-type turf (primarily Poa pratensis) at the Horticultural Research Station at Cambridge and on fairway turf (mixed Poa annua and Agrostis palustris) at the Weston Golf and Country Club, Weston, Ontario. At both locations, Turf fertilized with the Windsor material was as good as turf fertilized with a urea-based fertilizer. At the Cambridge site, the Windsor material performed as well as Milorganite. There appeared to be no difference in thatching tendency, susceptibility to drought or disease, in turf color or turf growth. On the golf course fairway, the speckling commonly note with urea was not evident with the Windsor material. A Poa Annua sward has been established at the Cambridge site to evaluate the response of this species to the Windsor material and Milorganite during 1987.

ABSTRACT FORM

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Project No. : 209 PL Liaison Officer: J. Manual Phone: 323-5125

KEY WORDS : Waste Management, Pharmaceutical Wastes.

Title: Waste Management Planning for Pharmaceutical Industry
Phase I, Inventory and Data Collection

Abstract:

The survey of waste generated by the pharmaceutical industry in Ontario is almost complete. The questionnaire originally prepared by the Ministry was modified, and was sent to approximately 70 establishments (manufacturers, hospitals and distributors). We have received responses from a little over 60% of the recipients. On the basis of replies received, it is apparent that most wastes are incinerated or sent to landfill. Notable quantities are, however, going to municipal sewers, including some psychotherapeutics, corticosteroids, and biologicals. These are being further investigated. The paper will discuss these and other findings in some detail, our tentative recommendations and plans for further work.

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Project No. 217 RR Liaison Officer: D. Hickman Phone: 323-5206

KEY WORDS : Industrial Waste, Waste Utilization.

Title: Development of Guidelines for the Utilization of Industrial Waste In Backfill and Construction Applications.

Abstract:

The proposed evaluation guideline used to assess the suitability of industrial waste materials for various backfill and construction options will be presented. The rationale underlying the guidelines will be reviewed and the specific bulk material and leachate quality criteria for various disposal/utilization options will be detailed. Specific criteria will be presented for the following options:

- Lakefill/Shoreline Disposal
- Unrestricted Land Disposal
- Restricted Land Disposal
- Construction Applications

The second portion of the paper will review available Ontario data obtained from literature sources dealing with the bulk and leachate quality of the following waste materials:

Coal Ash - flyash, bottom ash
Foundry Wastes - slags, foundry sands,
foundry dusts, foundry sludges
Sewage Sludge Incinerator Ash
Cement Kiln Dust

ABSTRACT FORM

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Project No. : 104 PL Liaison Officer: R. Pearson Phone: 965-4516

KEY WORDS: Hazardous Liquids, Spill, Waste Migration, Permeability.

Title: Numerical and Laboratory Modelling of Two-Phase Flow in Porous Media: 1. Two-phase gaseous flow. II. Two-Phase Liquid Flow.

Abstract:

Numerical and laboratory modelling of two-phase fluid flow in porous media is taking place under a larger project "Assessing the Impact of Hazardous Liquids spilled onto Soil." Numerical models to simulate two-phase liquid and vapour situations have been developed, and early verification against laboratory data has produced very good results. Liquid phase experiments are monitoring the migration of an immiscible liquid through a sixty cm. water-saturated vertical sand column. Relative liquid saturation behind the intruding front is monitored to steady-state with the thermal conductivity probe developed at UW. Relative permeability curves as a function of oil and water relative saturations have been developed.

Two phase gaseous flows are being modelled in a 4 x 1.3 x 0.3 metre sandbox. Hexane liquid is introduced in a pan and allowed to volatilize and migrate away from the source. Numerical and laboratory results are compared to determine soil absorption properties and variabilities in the parameters governing hazardous diffusion in porous media.

ABSTRACT FORM

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Project No. 233 PL Liaison Officer: A. Oda Phone: 323-5129

KEY WORDS : Waste Treatment, Cyanide Waste, Polysulfide Sludge.

Title: Development of Polysulfide Technology for Treatment of Concentrated Spent Cyanide Liquors.

Abstract:

The polysulfide reaction offers a possibility for a simple effective, and inexpensive pre-treatment of concentrated spent cyanide liquors which are a troublesome byproduct of electroplating. The feasibility of such pre-treatment has been confirmed in previous studies but several technological questions remained unanswered.

In this study extensive tests on spent plating solutions of various concentrations and origin have been performed with an application of calcium and sodium polysulfide. The purpose of these experiments was to establish the reliability of the process and its optimal conditions.

To eliminate possible problems with supply of commercial grade calcium polysulfide in bulk quantities, and at a reasonable price, experiments have been carried out on an on-site production of polysulfide agent from lime and sulfur. A preliminary economical evaluation of such a production has been formulated.

The sludge generated during the polysulfide reaction with the spent liquors has been characterized under laboratory scale conditions. More tests in a pilot scale are intended.

ABSTRACT FORM

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Project No. : 244 RR Liaison Officer: A. Oda Phone: 323-5129

KEY WORDS : Leachate, Landfill, Treatment, Spray Irrigation, Muskoka Lakes.

Title: Treatment of Landfill Leachate by Spray Irrigation - Muskoka Lakes

Abstract:

This research addresses present and potential problems arising from the installation of a spray irrigation system designed to concentrate leachate from the Muskoka Lakes Landfill onto a nearby forested area of mixed hardwoods. The forest is now showing severe mortality in areas where spraying has been previously concentrated. A brief summary of past and ongoing activities is presented.

Surface and subsurface hydrological investigations have been undertaken with a view to reducing the volume of leachate being generated from the estimated current mean rate of about 60,000 $1.day^{-1}$. Feasibility studies are underway to investigate practical means of reducing i) the infiltration of incident precipitation through the landfill cover and ii) the extent of groundwater contact with landfilled refuse.

The ability of the local soils to attenuate spray irrigated leachate is being studied in the field via soil water regime characterization and soil solution/groundwater sampling, and in the laboratory with intact soil leaching columns.

Time sequenced infra-red aerial photography is being used to monitor the severity of perceived stresses imposed on the mixed hardwood forest ecosystem through the growing season. More precise field measures of transpiration rate and vegetative growth depression are being made with a porometer and increment bore/foliar nutrient sampling, respectively. Influences of leachate spraying on soil microbial biomass and respiration are also being ascertained. The latter employs a soda-lime CO_2 absorption field assay. A greenhouse experiment utilizing red and sugar maple seedlings, subjected to foliar and soil applications of untreated, lime-treated, and activated carbon-treated leachate will assist in further isolating the nature of the vegetative stresses apparent in the forest from past spraying sequences.

ABSTRACT FORM

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Project No. : 156 PL Liaison Officer: M. Fielding Phone: 323-5146

KEY WORDS: Industrial Waste, Municipal Waste, Waste Disposal, Landfill.

Title: Co-Disposal of Industrial and Municipal Wastes. Part II.

Abstract:

This work is part of a longer term study of factors involved in the mobilization of metal species from solids contained in a landfill environment. Current methods of testing for the suitability of solids for disposal in municipal landfill sites do not take into account the anaerobic environment generated by microbial action or the role of biological metal mobilization, and thus the screening tests may not provide the appropriate information required.

In an earlier report the standard EP leach test for a steel flue gas dust was compared with modified leach tests with mixed municipal refuse and the steel flue gas dust. In this report, results from experimental landfill test columns are presented. The columns are designed to provide data on metal mobilization within a municipal refuse landfill with and without various loadings of the steel flue gas dust. Both atmospheric and controlled water input are compared.

The results of the work show that the presence of the industrial waste has a beneficial effect in inhibiting the release of many metal species over the timeframe studied.

ABSTRACT FORM

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Project No. : 118 PL Liaison Officer: M. Goodwin Phone: 323-5217

KEY WORDS : Hazardous Organics, Groundwater, Landfill.

Title: Hazardous Organic Chemicals in Groundwater at Ontario Landfills

Abstract:

Studies have been conducted at five landfills in Ontario ranging in latitude from the North Bay landfill in the north to a landfill near Sarnia in the south. The sites represent a variety of geologic materials in which migration of leachate-derived contaminants occurs, including sand aquifers, sandy silty glacial till, clayey glacial till and fractured shale. With the exception of the clayey till site, at each of the sites extensive lateral migration (200 m - 1000 m) of organic contaminants, particularly the common volatile organics, has taken place. These landfills range in age from one to three decades. The total dissolved organic carbon in the contaminated groundwater is generally in the range of 10 to 200 mg/l. The total load of identifiable organic compounds is only a small fraction of this total. The nature of the suite of characteristic volatile organics differs considerably from landfill to landfill, and to some degree reflects the nature of the industrial base of the municipality. The spatial distribution of volatile organics within each plume is generally much more complex than the distribution of the standard plume indicator parameters such as total dissolved solids, electrical conductance, total dissolved organic carbon and chloride. The design of effective monitoring networks for trace organic contaminants is therefore more difficult. At the landfill on clayey glacial till, the downward migration of Cl^- and volatile organic compounds was determined through work done in collaboration with the Oregon Graduate Center. Vertical cores were collected from the bottom of a five year old hazardous waste-disposal pit in unweathered clayey material. These cores show that downward contaminant migration has occurred due to molecular diffusion without significant influence of groundwater flow. Chloride has diffused 85 cm in 5 years. Volatile organic compounds have moved at a slow rate due to adsorption. The clayey till below the pit site is 26 m thick and therefore the aquifer below is not threatened. In a different context, however, the results indicate that molecular diffusion is a process that will cause contaminants to move through compacted clay liners relatively quickly even if the liners achieve a very low permeability.

ABSTRACT FORM

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Project No. : 261 RR Liaison Officer: A. Mallory Phone: 424-3000

KEY WORDS : Stouffville, Contaminants Plume, Groundwater, Water Quality.

Title: Dispersion of the Stouffville Contaminant Plume

Abstract:

The quality of groundwater in the Oak Ridges aquifer complex underneath the Stouffville landfill site has been monitored since 1968. Data on many chemical parameters allow dilineation of the contaminant plume, and assessment of its evolution with time.

Previous work has identified a thick unsaturated zone occurring above the aquifer, with perched groundwater in the overlying Halton till. Numerous ponds present in the area suggest that little recharge takes place areally through the till. A recent IGR study in the Musselman lake area, immediately upgradient of the site, has described the recharge characteristics of the aquifer. A computer model to represent the groundwater flow is now applicable.

Present work aims at gaining more information on the physical properties of the glacial outwash forming the acquifer, in order to enable a characterization of the strength of the dispersion process. Focus is on the degree of heterogeneity and the spatial arrangement of the hydraulic properties.

ABSTRACT FORM

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Project No. : 153 PL Liaison Officer: M. Goodwin Phone: 323-5217

KEY WORDS : Leachate Recovery, Sanitary Landfills, Landfill Design.

Title: Development of Design Criteria for Optimal Recovery of Leachate Under Sanitary Landfills.

Abstract:

A two-dimensional finite element model was used to study the effectiveness of tile drain systems for capturing leachate escaping from sanitary landfills. Computed steady-state conditions were compared with data produced from a laboratory model with a homogeneous and isotropic sand medium. Simulations were conducted for single drain configurations with varying vertical hydraulic gradients, drain depth, thickness of the flow field, drain spacing and recharge rate. Results showed that most of the fluid or leachate could be collected if an upward gradient existed between the drain level and the bottom of the system. If the gradient was downward, the drains had to be very closely spaced in order to collect the fluid. Drain performance depended also on the rate of recharge to the system. The amount of recharge controlled, in part, the height of the groundwater mound between the drains. Optimum conditions were attained when all the leachate was collected with minimum infiltration from the underlying hydrogeological unit.

The numerical model was also used to verify the influence of a network of drains on regional groundwater flow. Resulting flownets illustrate the influence of regional horizontal gradients, recharge, thickness of the aquifer, and drain depth on the amount of water collected. For homogeneous and isotropic systems, the influence of the drains can be observed deep inside the flow field.

Numerical simulations were performed for cases of anisotropy in the porous medium and for cases having a less permeable layer of varying depth, thickness, and relative hydraulic conductivity. These results show that anisotropy and heterogeneity can affect significantly the performance of a given drain system design.

Both systems under study (single drain and regional) are useful to evaluate the role of tile drains as leachate and groundwater collectors.

ABSTRACT FORM

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Project No. : 151 PL Liaison Officer: H. Tosine Phone: 323-5906

KEY WORDS: Gloucester, Leachate Plume, Landfill, Groundwater.

Title: An Investigation Into The Redox Conditions Of A Landfill Leachate Plume Containing Volatile Organics, Gloucester, Ontario

Abstract:

Recent research has indicated that the rate of degradation of volatile organic compounds in ground water is dependent on the existing redox conditions. In general, aromatic compounds degrade most quickly under aerobic conditions while aliphatic compounds are most quickly degraded under anaerobic conditions. A detailed redox survey was carried out at the Gloucester Landfill site, Gloucester, Ontario, in 1985, to establish the redox conditions within a contaminant plume containing volatile organics. The redox conditions at 129 sampling points throughout the plume were characterised three ways: (1) pH measurements were made using a platinum electrode connected to a flow cell. pH and temperature probes were also connected to the flow cell so that all three field measurements could be recorded at the same time; (2) dissolved oxygen measurements were carried out with a second, independent, flow cell; (3) field and laboratory measurements of sulfate and sulfide concentrations in the ground water were carried out. These values were used to calculate a Nernstian "pe" for each sampling location. A concurrent study into the distribution of volatile organics on the site provided the contaminant data.

EH measurements made with a platinum electrode were found to be very imprecise. It is recommended that in future studies they be used only as a reconnaissance tool. Dissolved oxygen measurements and "pe" calculations were found to best delineate aerobic and reducing environments, respectively.

The possibility that redox controlled chemical and/or biologically mediated transformations are taking place at the site will be addressed by identifying possible parent and daughter compounds and examining their distributions within the reducing and oxidizing environments.

ABSTRACT FORM

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Project No. : 213 PL Liaison Officer: M. Goodwin Phone: 323-5217

KEY WORDS : Organics, Domestic Waste, Leachate, Hydraulic Conductivity, Clay Liners.

Title: Effects of Increasing Amounts of Non-Polar Organic Liquids in Domestic Waste Leachate on the Hydraulic Conductivity of Clay Liners in Southwestern Ontario.

Abstract:

Organic liquids, less polar than water, are capable of producing dramatic changes in the structure of clayey soils and their hydraulic conductivity. Double layer theory is adequate to explain the behaviour of pure liquid-clay mixtures, however, it fails to account for the behaviour of water-compacted clays sequentially permeated by water and organic liquids. The "hydrophobic" nature of non-polar liquids such as cyclohexane and benzene, restricts their flow to larger channels through the pore system, resulting in decreases in **k** and with little effect on the double layers of water. The values of **k** seem to be dependent on the hydraulic gradient applied (non-Darcian behaviour) and threshold gradients may be measured below which breakthrough a flow do not occur. Viscosity plays an important role on the behaviour of water-soluble permeants such as ethanol and dioxane, producing an initial decrease followed by gradual increases in **k** to equilibrium values that are practically independent of the hydraulic gradient used.

The addition of organic liquids induced rapid flocculation of the otherwise stable suspended matter in domestic waste leachate, the rate of flocculation being more pronounced with increasing abundance of organic liquids. Inorganic salts also precipitated resulting in a decrease in salinity of the clear leachate phase. The physical location of the flocs (as floaters or sinkers) depends on the amount and type of organic liquid added.

Preliminary testing on water-compacted brown Sarnia soil using the clear phase of domestic leachate containing up to 45% ethanol and 5% benzene has yielded no significant increases in **k**. Furthermore, leachate spiked with 20% ethanol produced a decrease in **k** that is believed to be due to its higher viscosity.

Solubility limits mean that large amounts of most non-polar organics will generally produce two liquid phases. Additional testing will be presented showing the results of **k** testing at high and low organic contents. Special tests using non-polar but totally water-soluble dioxane will also be presented.

ABSTRACT FORM

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KEY WORDS: Welland River, Contaminant Fate, Industrial Site, Analysis, Sediment.

Title: Assessment of Contaminant Migration from Industrial Sources Dicharging to the Welland River

Abstract:

A team of 3 chemists, 3 aquatic toxicologists, 2 genetic toxicologists, 3 environmental studies scientists, 2 field workers and 1 project coordinator collected and tested samples from the Welland River below major industries. The impact which these effluents had on the first, invertebrates and aquatic vegetation of the Welland River was described in terms of four biological zones: 1) Impact zone, 2) Primary Recovery zone, 3) Secondary Recovery zone and 4) Tertiary Recovery zone.

Chemical analyses of the effluents and the receiving waters and their sediments was correlated with the zonation pattern described above. In general, the larger the area of the impact zone the more toxic the effluent. Chromotoxicity and Ames testing of the effluent and sediments of each source was also conducted. Preliminary chemical analyses confirmed a definite relationship between contaminant levels and the effects on the Welland River biota.

Continuous specific conductivity tests of the effluents form selected industries revealed with sporadic discharges (shock loads) of electrolytes were entering the Welland River. When the biotoxicity testing was performed using effluent discharged during these shock loading events the biotoxicity was far higher than when effluent displaying background conductivity levels was used. When the data was provided to one of the industries in this study a cooperative program was established. In this case the industry actively solicited the cooperation of our investigative team in pin-pointing the source of its shock load discharges. The source as traced to their Vacuum Oxygen Refining System which has now been renovated to prevent shock loading to the River. This work has established the precedent for cooperative toxicological research between industries on the Welland River and our investigative team at Brock University.

ABSTRACT FORM

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Project No. : 214 RR Liaison Officer: A. Scott Phone: 323-5218

KEY WORDS : Groundwater, Burlington, Oakville, Landfill.

Title: Evaluation of Contaminant Velocity Groundwater in Low-Permeability Fracture Shale.

Abstract:

This study, which began in August 1985, focuses on methods for determination of velocity and, to a lesser degree, dispersion in fractured shale. Emphasis is placed on bedrock shale in the Burlington-Oakville region. Shale in this region is important because it occurs at or very near ground surface in many areas where landfilling or industrial activities take place. The shale is not very permeable but nevertheless groundwater velocity can be relatively high in some zones. This study involves detailed field tests at a field site in Oakville (a second field site may be selected in the second year of this project). Field results are being used to develop improved modeling approaches for flow and contaminant migration in the shale. At the field site cored boreholes have been drilled, specific zones of fractures have been identified and hydraulic testing using two types of borehole packer have been performed. Larger scale tests to determine the hydraulic continuity of fracture zones are in the planning stage.

ABSTRACT FORM

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KEY WORDS : Clay Till, Nanticoke, Waste Disposal Leachate, Contaminant Migration.

Title: Geomechanical Investigation of Near-Surface Fractures in Clay Tills: Part 2: Laboratory Investigation of Strength and Mineralogy

Abstract:

Three sites were chosen across southwestern Ontario for the purpose of studying the characteristics of the near-surface weathered and unweathered zone in the clays and clay tills. In an attempt to determine the regional characteristics of these altered sediments, the sites were selected as to represent three distinct geomorphological areas found across southwestern Ontario: 1) the Nanticoke site located in the varved lacustrine Haldimand clays, 2) the London site located on Port Stanley till, 3) the Essex site located on the "water-laid" tills of the St. Clair clay plains region.

The first part of this study dealt with the fracture patterns and fracture-forming mechanisms observed at each site. This laboratory portion of the study has made use of 4 inch diameter Shelby tube samples collected from the weathered and unweathered zones. Standard geotechnical characterization tests were performed such as grain-size analysis, Atterberg limits and oedometer consolidation tests. A series of multi-stage, consolidated-undrained triaxial tests were also performed to determine differences in stress-strain behaviour between the weathered and unweathered sediments, as well as the lacustrine clay and till deposits. Tensile strength tests using laboratory hydraulic fracture were also attempted on the intact and fractured clay samples to complete their geomechanical characterization.

The mineralogy of the weathered and unweathered zones, as well as the fracture infilling material, were determined using standard X-ray diffraction techniques.

This paper concludes with a discussion on the laboratory strength and mineralogy of the near-surface clays and clay tills found in southwestern Ontario and how these characteristics have been altered through the weathering process. The implication of these changes upon the siting, construction and long-term behaviour of waste management facilities located on clay deposits are examined.

ABSTRACT FORM

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Project No. : 145 PL Liaison Officer: P. McKenna Phone: 323-4892

KEY WORDS : Groundwater, Chlorides, Aquifer.

Title: Origins of Elevated Chloride Concentrations in Groundwater Systems

Abstract:

Shallow aquifer systems in southern Ontario frequently exhibit elevated chloride concentrations that locally exceed water quality guidelines. While in some cases the elevated chloride concentrations can be attributed to indigenous sediment sources, more commonly they are introduced by external point and non-point sources of both natural and man-made origins. Natural origins primarily include formation waters resident in underlying Paleozoic sediments; manmade origins are numerous and include road de-icing chemicals, inorganic fertilizers, urban development, landfills, septic tanks, and animal feedlots.

At the University of Toronto, hydrochemicl studies are in progress that aim to develop multi-parameter methods of identifying sources of groundwater contamination. Chemical parameters have included major ions (Ca, Mg, Na, K, Cl, SO_4, NO_3 and HCO_3) minor ions (Br, I, and F), and over 20 trace metals. Tritium has been used locally. To date the study has focused on road de-icing chemicals, saline bedrock waters, fertilizers and urban development as the primary external sources of the chloride enrichment. A total of 110 domestic well water samples, 40 contaminant samples and 70 interstitial water samples have been collected and analyzed.

Much of the completed work has been aimed at determining the natural background levels of major, minor and trace chemical constituents in naturally evolving uncontaminated groundwaters. In addition attempts have been made to characterize chemically the major sources of contamination in the area and, more importantly, to develop an understanding as to how the chemical characteristics of the contaminants are modified during transport through the shallow sub-surface. In general, the minor inorganic anions (I, Br and F) have provided to be the most reliable indicators of chloride origin, being particularly effective at distinguishing between bedrock and road de-icing chemicals as sources of saline wter. Although relatively few of the trace metals have shown anomalously high concentrations in the chloride enriched groundwaters, there are strong indications that Al, Ni, Ba, Cu, Zn and Pb may prove beneficial indicators of contaminant origin in specific situations.

ABSTRACT FORM

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Project No. : 204 RR Liaison Officer: W. Suboch Phone: 323-4884

KEY WORDS : Reverse Osmosis, Cheese Whey.

Title: Evaluation of Reverse Osmosis Technology for Cheese Whey Concentration

Abstract:

Whey, a by-product of cheese production, is recognized as being potentially valuable material, however, the predominant driving force behind the development of whey processing technology has been environmental rather than product recovery.

Recent application of membrane processes, such as reverse osmosis, to cheese whey held the promise of not only less rigorous whey management requirements because of volume reduction through concentration but also the possibility of economic benefits. These benefits arise from the practical reuse of whey concentrate for livestock feed supplementation and reuse of the high quality permeate for boiler make-up or washwater. Verification of the real suitability of this technology to the cheese production industry was lacking.

A critical evaluation was made of a 7200 l/hr. reverse osmosis system used at a major cheese production establishment to effect a twofold concentration of whey. The evaluation comprised a technico-economic assessment which included analytical characterization of feedstock and products, a detailed review of the system design parameters and operating procedures, including membrane cleaning/sanitation, and a consideration of the impacts arising from the use of the produced permeate as boiler make-up. Although certain improvements were required, the system performance generally met design specifications with respect to product quality and the anticipated benefits were substantially realized. Specific recommendations for the application of reverse osmosis systems in the cheese production industry were made.

ABSTRACT FORM

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Project No. : 166 RR Liaison Officer: W. Suboch Phone: 323-4884

KEY WORDS : Cheese Whey, Waste Treatment.

Title: Cheese Whey Treated by Kenox(R) Process

Abstract:

A study was carried out by Stone & Webster Canada Limited to asses the technical integrity of the Kenox (R) Process and to ascertain any economic or technical advantages offered by this process for the treatment of cheese whey wastes.

The Kenox (R) Process is a wet air oxidation process, which employs a unique design to obtain the necessary degree of mixing between waste stream and air (as the oxidant) at elevated temperatures and pressures.

Experiments were carried out on a prototype installation situated at a Downsview, Ontario cheese manufacturing plant.

This assessment indicated that a reduction of 67% of the biochemical oxidizable matter in cheese whey, as measured by "Biochemical Oxygen Demand" (BOD_5) for a single pass operation (12 minutes reactor residence time) and a 92% BOD_5 reduction for a "total recycle" operation (48 minutes reaction residence time) is achievable with the Kenox (R) System. The heat exchanger system was not suitable for cheese whey due to exces fouling problems which caused extensive delays and operating time losses. An auxiliary treatment system would be required to bring the BOD_5, suspended solids (S.S.) content of the effluent from Kenox (R) System to limits set by Metro Toronto's By-law 148-83 (BOD_5 = 500 mg/L, S.S. 600 mg/L).

Usable heat, in the form of hot water at 140°F, was recovered from the process at a rate of approximately 770,000 Btu/day, when the unit was operating at a feed rate of 1 USgpm cheese whey.

In its present state of development, the Kenox (R) System does not appear to present an economic advantage to the Downsview Cheese Manufacturing Plant because of the unique problems encountered in dealing with cheese whey. However, it clearly has a viable future in the treatment of waste streams and could become attractive in a wide variety of situations.

SECTION D

ANALYTICAL METHODS

ABSTRACT FORM

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KEY WORDS : 1Emission Spectorscopy, Multielemental Analysis, Sample Introduction.

Title: Direct Solid Sample Analysis with the Direct Sample Insertion Device, Promise and Problems

Abstract:

The spectrometer and data acquisition requirements for solid sample analysis with the direct sample insertion device (DSID) will be discussed with respect to speed and background correction. The DSID requires a multichannel spectrometer for multielement analysis, however the rapid spectral background correction requirements drastically limit the selection of both the wavelength correction scheme and manufacturer. The results of preliminary work in our and other laboratories will be presented. Investigations of marine sediment samples have demonstrated detection limits which are sufficiently low to permit the detection of some elements at the sub ug/g level. The reproducibility of the signal for the marine sediments is poor and is suspected to be due to the inhomogeneity of the sample and the small sample size (2 mg). Other laboratories have succeeded in obtaining reproducible signals from larger samples (10 mg) of graphite, silicon dioxide and aluminum oxide based standards. Common linear calibration curves have been obtained for these standards. The use of other sample supports such as metal cups will be discussed as well as the use of Oxygen - Argon mixtures and halogen mixtures. The potential as well as the application of fluxes will be demonstrated for the generation of conditions suitable for sample breakdown.

ABSTRACT FORM

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KEY WORDS : ICP-US, Multielement Analysis, Analysis-Air, Analysis-Water.

Title: Screening Methods for Air and Water Samples: Application of Inductively Coupled Plasma Mass Spectrometry (ICP/MS) to Elemental Analysis

Abstract:

Re Filament and graphite boat volatilizers (electrothermal vaporizers-ETV's) have been evaluated as sample introduction devices for ICP/MS. The elements studied to date include Cu, Cd, Ni, Fe, Pb, V, Sn, Au, P and Se. The Re filament can be used for the more volatile elements but elements such as V, Sn, P and Se are better handled using the graphite boat. Typical operational parameters for the Re filament are as follows: Ar flow 4.0 l/min, max T 1900°C, incident power to plasma 1.25 kW, sample size 2-5 l. The graphite boat can be used to about 2500°C. Calibration is by the method of standard additions. Both devices give up to 80% transport efficiency when a 5 to 10 ml volume exists in the glass dome above the filament (to allow aerosol condensation into microparticulate before it reaches the glass or tubing surface). Tangential Ar gas introduction is also used to aid minimization of aerosol interaction with ETV surfaces.

Detection limits using ETV sample introduction are up to 1.5 order of magnitude superior to those obtained on the same ICP/MS when cross flow nebulization is used. Ionization supression interference were minimized through ashing programs Mass spectral overlap was a problem when large amounts of Zn^{64} was present with Cu and Cu^{65}.

ICP source mass spectrometry has undergone preliminary investigation as a new mass specrometric detector for chromatography. The compounds separated by gas chromatography and detected were Me_3SnPe, Me_2SnPe_2 and $MeSnPe_3$. Introduction of O_2 into the gas flow from the GC was essential to prevent graphite build up in the torch. The use of O_2 also improves detection limits by 3 orders of magnitude.

ABSTRACT FORM

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Project No. : 222 RR Liaison Officer: R. Sadana Phone: 235-5863

KEY WORDS : Analysis-Water, Selenium, Phytoplankton.

Title: Development of Selenium Analysis Methodology at Ng/L Levels for Soft Waters Subject to Acidic Precipitation

Abstract:

Our studies of nutritional factors important in controlling the composition of phytoplankton populations have indicated that some phytoplankton species in softwater lakes subjected to acidic precipitation require the element selenium for growth. Some of these phytoplanktons produce undesirable blooms. The levels of selenium required by these species is low. However, the meagre data available on Se concentrations in softwater lakes indicate that Se levels may be low enough to limit the growth of some phytoplankton, and that Se inputs from acidic precipitation, a known source of Se, may affect the composition of these communities. Because of the dearth of data on Se levels, it was decided to apply a sensitive method to analysis of this element in soft waters. In addition the known effects of Se in ameliorating some of the toxic effects of Hg suggest that Se may be important in soft waters for other reasons.

Atomic absorption methods as conventionally applied yield a detection limit in the ug/L range. This is inadequate for the studying the levels normally encountered in softwater lakes. A gas chromatographic method was applied and allowed detection at the low ng/L level. Several new features of this method have not been used previously in analysis of Se in natural waters. These include application of capillary chromatography to analysis of the piaselenol derivative (of 4-nitro-o-phenylenediamine) in soft waters, and a single flask derivatization procedure which considerably reduces handling and potential contamination. Retention time of the piaselenol peak was about 1.8 min with total analysis time of 5 min, at an operating temperature of 250°C. Preliminary data indicate that Se concentrations vary with season and depth and are typically less than 1 ug/L in softwater lakes. The method can also be used to study the distribution among the various species (Se-IV, Se-VI and organoselenium).

ABSTRACT FORM

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Project No. : 188 PL Liaison Officer: P. Campbell Phone: 235-5872

KEY WORDS : Analyzer, Organic Carbon, Digestion.

Title: Evaluation and Optimization of a T.O.C. Analyzer Utilizing U.V. - Persulphate Digestion

Abstract:

A series of tests were designed to evaluate the performance of a commercial total organic carbon analyzer which utilizes an automated UV-persulphate digestion. Initial tests explored the sensitivity, precision and accuracy of the machine. A practical lower limit of detection was approximately 0.5 mg C/L. One problem identified was the inability of the machine software to incorporate more than one calibration standard. As a result, some non-linearity was observed at the extremes of the calibration range.

Synthetic samples were prepared which incorporated a range of organic and inorganic carbon concentrations. These samples were analyzed in a double, blind test in comparison with traditional O.M.E. furnace techniques. The results of these tests indicate that, in general, U.V.-persulpahate digestion is capable of complete digestion and recovery of organic carbon. No systematic bias was found even in highly refractory samples such as isonicotinic acid. Paired "t-tests" between the two analytical methods revealed no significant differences between means.

The last phase of the study involved the comparison of various carbon fractions as measured with this technique with traditional determinations of organic content such as biological oxygen demand (BOD) and chemical oxygen demand (COD). Results of this phase of the study were variable. In some situations there was a good correlation between BOD and either total carbon or organic carbon but in most cases, the correlations were poor. As expected there was no correlation between inorganic fractions of carbon and oxygen demand. The results suggest that in some cases this instrument could be used as a fast screen for oxygen demanding wastes but further study is required to define the matrices for which the method is most applicable.

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KEY WORDS : Spectrometry, Nebulizer, Multielement Analysis.

Title: Development of an Ultrasonic Nebulizer for Stable and Reproductive Production of Aerosols for Atomic Spectrometric Analysis

Abstract:

The object of this work is to determine the feasibility of the construction and utilization of a relatively inexpensive but reliable ultrasonic nebulization system. The device should be applicable to the trace element analysis of environmental samples. The starting point for the investigation was a commercially available ($100) transducer/power supply used in a humidifier system. To date the majority of the research has involved design, modification and subsequent evaluations of suitable spray chamber-desolution atomizer equipment. Additionally modifications were found to be essential in the transducer power supply and housing systems. Research is now centering on methods of coating the transducer (as opposed to the usual and unreliable quartz plate bonded system) to obtained reproducible and reliable substrate form which to generate the sample aerosol. No useful quantitative results have yet been obtained.

ABSTRACT FORM

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Project No. : 154 RR Liaison Officer: M. Young Phone: 235-5790

KEY WORDS : Toronto, Beaches, DNA Probe, Fecal Pollution.

Title: Development of Recombinant DNA Probes to Determine the Origin of Fecal *Streptococci* at the Toronto Area Beaches

Abstract:

Total cellular DNA from fecal *Streptococci* from goose, human and gull origin were digested with restriction endonucleases. The digestion patterns were grouped into families by visual inspection for commonality. An isolate from goose feces was chosen as a candidate for preparing the goose probe because this "family" included both sediment and fecal isolates.

The total cellular DNA was digested with the restriction endonuclease Bam HI and inserted into the Bam HI site of the cloning vector pUC 9. The colonies of *E. coli* which had been transformed by a recombinant plasmid were screened for plasmid content. The plasmids were digested with Bam HI and electrophoresed in agarose gels. The DNA was transferred to millipore membranes and probed with 32P-labeled total cellular DNA from *Streptococcus faecalis var liquefaciens* of human origin. An insert of 6.6 Kb which did not hybridize to the probe was chosen as a candidate for the goose streptococcal DNA probe. This plasmid was radiolabeled with 32P and used to analyze the total cellular DNA of fecal *Streptococci* of goose, human and gull origin. The probe hybridized to the "family" of goose fecal DNA from which it was derived and not the human fecal streptococcal DNA of non-lab workers. In addition only one of twenty (1/20) gull isolates reacted positively.

In a similar manner a probe for human fecal streptococcal DNA was generated from *Streptococcus faecalis var liquefaciens* of human origin and candidate recombinant plasmids were selected by their inability to hyrbidize with the total cellular DNA of *Streptococcus var liquefaciens* of gull origin. A plasmid with an insert of 2.0Kb was found to react with four of twenty (4/20) fecal streptococcal DNA of human origin but not with any of goose or full origin.

ABSTRACT FORM

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Project No. : 169 PL Liaison Officer: D. Rokosh Phone: 235-5787

KEY WORDS : Mutagens, Biomonitoring, Plant Bioassay.

Title: Plant Bioassays for the Detection of Environmental Mutagens

Abstract:

It is well established that higher plants provide valuable assay systems for screening and monitoring environmental chemicals (de Serres 1978; Grant 1978; Nilan 1978), this project "Plant Bioassays for the Detection of Chemical Mutagens" was initiated in order to have a different relatively inexpensive mutagen assay system (using higher plants) which would provide a measurement of mutagenic toxicity in assay systems not being carried out by the Ontario Ministry of the Environment. This study involves the use of two higher plants, namely, Tradescantia and Barley (Hordeum vulgare). Each plant has two different assay systems. The two Trandescantia assay systems are: (1) the Stamen Hair Assay for the detection of gene mutations, and (2) the Micronucleus Test for the detection chromosomal aberrations. The two assay systems in barley are: (1) the Root Tip Chromosomal Aberration Assay and (2) the Chlorophyll Mutation Assay. Ethyl methanesulfonate (EMS) is being used as positive control. Tests are being completed on three herbicides, namely, alachlor (Lasso), atrazine, and metolachlor. Preliminary results indicate all three herbicides give a positive response in these plant assays. The herbicide atrazine is strongly mutagenic. The number of mutations from a dose of 50 ppm exceeded the number produced by a 250 ppm dose of EMS used as a positive control. Metolachlor also is mutagenic with the number of mutagenic events from a 240 ppm treatment exceeding the equivalent of 250 ppm EMS. In the stamen hair assay, the mutagenicity of Lasso was not significantly different from the control, however, Lasso caused a high percentage of chromosome aberrations in the micronucleus assay which was double those resulting from a 500 EMS treatment. Lasso also induced fragments in the barley chromosome aberration assay. From the chromosomal data, Lasso is considered to be a strong clastogen. The results to date indicate that higher plant assays are highly suitable for testing for the mutagenicity of environmental chemicals from air, soil and water habitats.

ABSTRACT FORM

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Project No. : 215 PL Liaison Officer: J. Ralston Phone: 323-4924

KEY WORDS : Toxicity, Neoplasia, Aquatic Organisims, Molluscs, Sediment, UraNIUM Refinery, Port Hope.

Title: A Biological Indicator System to Identify Genotoxicity of In-Place Pollutants

Abstract:

Morphological abnormalities are often observed in chironomid larvae collected from areas of industrial or agricultural pollution, and have been reported to be more common in these areas than in unpolluted sites. Such observations suggest that chironomid larvae could be useful as indicators of genotoxicity in sediments. However, field studies have not demonstrated correlations between deformity incidence and levels of particular pollutants.

A laboratory study was undertaken to determine whether mouth part abnormalities similar to those observed in the field could be induced by a known genotoxicant, ethyl methane sulfonate (EMS), either in exposed chironomids or in their unexposed offspring.

Abnormal development of the hypostomial plate was induced by chronic embryo-larval treatment with EMS at a nominal exposure level of 240 mg/L, approximately 80% of the chronic LC50 concentration. At this exposure level the deformity incidence (46-50%) was more than doubled relative to controls. Non-significant elevation of deformity incidence was observed at 75 and 100 mg/L, in proportion to the exposure level.

Emergence and reproduction of adults was severely inhibited by EMS embryo-larval exposure levels of 75 and 100 mg/L. At these concentrations few viable adults emerged, and matings between treated males and untreated females produced inviable eggs. Either male infertility or embryonic expression of induced dominant lethal mutations could be responsible.

Emergence and reproduction were apparently normal following embryo-larval exposure to 50 mg/L. However, the incidence of hypostomial deformities in untreated F_1 offspring was increased relative to the exposed parents and relative to concurrent control cultures. This result was based on a single F_1 culture and was not statistically significant.

The incidence of hypostomial deformities in control larvae was variable (5 to 21%) and higher than typically observed in larvae collected from unpolluted field locations. Possible factors contributing to control deformities include physical abrasion of early instar mouthparts, and inbreeding of laboratory cultures. An inbreeding effect was suggested by an increase in control deformity levels over three successive generations.

ABSTRACT FORM

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KEY WORDS : Biomonitoring, Clams, Nearshore Environment, Lake Erie Metals.

Title: Freshwater Clams as Monitors of Variation in Environmental Acidity and Trace Metal Levels.

Abstract:

Freshwater clams are commonly used to biologically monitor contaminant levels in aquatic environments. In areas affected by acid rain, trace metal availability to aquatic organisms is enhanced. To help determine the heritability of trace metal uptake rates into clam tissues, we conducted a 3-way reciprocal transplant experiment in south-central Ontario using the unionid clam Elliptio complanata and 3 lakes which represent the "degree of acidification" gradient. The effects of transplant source and destination on uptake rates are discussed. Size- and age-specific patterns of trace metal uptake were investigated in these same clams. Irrespective of age, higher levels of Cd and Cu relative to Zn and Mn were found in clams from the more acidic environment. Clam size was generally a good predictor of tissue metal levels suggesting that longterm clam biomonitoring studies should control for size variability.

Although clam tissues are a useful monitor of short-term fluctuations in aquatic contaminant levels, clam shells can be used as indicators of longterm water quality patterns (individual clams can live up to 20 years). Researchers have speculated that small thin shelled clams are characteristic of an environment affected by acidification, since shells are primarily composed of Ca and Ca availability may be low in low alkalinity environments. We examined this theory by sampling E. complanata from 4 small lakes of varying alkalinity in south-central Ontario. We determined that most of the differences in shell size and shape were a function of within-lake variation in water turbulence. Therefore the use of shell morphology as a long-term predictor of acidification requires careful consideration of within-lake variability in shell form.

We are using a newly developed image analyser process which is coupled to a micro-computer based digitizer system to investigate patterns of shell erosion which have previously been attributed to increasing acidification. Variability in water turbulence appears to be an equally, if not more, important factor.

ABSTRACT FORM

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Project No. : 210 RR Liaison Officer: R. Clement Phone: 235-5896

KEY WORDS : Dioxins, Furans, Chromatography Analysis-Fish.

Title: Analysis of Dioxins and Furans in Fish and Other Biota

Abstract:

The method currently used by the Ontario Ministry of the Environment for the analysis of polychlorinated dibenzo-p-dioxins (PCDD) and dibenzofurans (PCDF) in fish is based on the Dow Chemical cleanup procedure. This method is time consuming and ineffective when high levels of PCB are present. Simultaneous determination of other environmental pollutants such as PCB, PAH, and chlorinated pesticides is not possible because of improper fractionation or poor recoveries. A new procedure has been developed in which the multi-step open column chromatographic cleanup devised by Dow is replaced by a two-step HPLC fractionation.

Fish tissue is digested overnight in concentrated hydrochloric acid and the organic compounds are then extracted with hexane. The organic extract is passed through a sodium sulphate/silica gel column to remove traces of water and lipid material. The resulting extract is then concentrated prior to HPLC fractionation.

Normal phase HPLC using a semi-preparative scale silica column and binary solvent system is used to isolate the PCDD and PCDF from the bulk of the complex organic matrix. Aliphatic hydrocarbons, substituted benzenes, some chlorinated pesticides, three-ring and larger PAH, and polar compounds such as phthalate esters can be fractionated and collected for subsequent analysis. The PCDD and PCDF are eluted along with PCB, chlorinated pesticides, and some substituted naphthalenes. A second step HPLC fractionation is then employed to isolate the PCDD and PCDF from the compounds interfering with their analysis. This separation is carried out using reverse phase HPLC with a C-18 column.

The two-step HPLC fractionation procedure is capable of efficiently removing PCB interferences form PCDD and PCDF even when the levels of the former are greater than 100,000 times that of the latter compounds. In addition, by collecting fractions in both the normal and reverse phase separations it is possible to simultaneously determine a wide range of target compounds from a single fish sample.

ABSTRACT FORM

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Project No. : 96 PL Liaison Officer: T. Ho Phone: 323-4980

KEY WORDS : Trace Organics, Effluent, Wastewater Analysis-Sewage, Chromatography.

Title: Development of A Cost-Effective Protocol for Routine Analysis of Trace Organic Contaminants in Municipal WPCP Raw Sewage and Final Effluent.

Abstract:

Further development and improvement of a highly efficient protocol for the detection of trace organics in municipal sewage and final effluent based on the simultaneous in-situ acetylation and extraction is presented. This method provides better sensitivity, allows greater sample throughput and reduces the cost of analysis.

The extraction performance originally based on a target list of chemical parameters chosen to represent various classes of compounds was expanded to include most of the EPA priority pollutants using organic-free water, WPCP raw sewage and final effluent as test substrates. The recovery parameters and their corresponding coefficients of variation prove that the overall protocol is comparable, or in some cases, better than the EPA method 625 for priority pollutant analysis.

Sample analyses were performed on a Hewlett-Packard 5890A Gas Chromatograph coupled with a Mass Selective Detector. Sufficient sample throughput has been achieved through automation of the GC/MSD system and its highly flexible data system. Customized menu-driven software was developed to improve the autosequencing flexibility in sample processing and interpretation, to allow generation of customized reports and implement error checking and quality control routines in the processing.

ABSTRACT FORM

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Project No. : 211 RR Liaison Officer: P. Baulu Phone: 235-5753

KEY WORDS : Chromatography, GC/MS, Multielement Analysis, Organics, PCBs, Analysis-Wastes

Title: Application of Gas Chromatography with Helium Microwave Plasma Detection to the Rapid Screening of Chemical Wastes

Abstract:

The element specific Helium Microwave Plasma Emission Detector (MED) designed and fabricated by Barringer will be described in this paper. The MED is capable of simultaneously monitoring a pre-selected group of elements such as C, Br, Cl, F, P and S on a low picogram detection level.

The detection system is based on a nine-channel polychromator monitoring the emission from a helium microwave plasma maintained in the Beenakker-type cavity. A gas control unit provided interfacing of the plasma to a Hewlett-Packard 5730 series gas chromatograph. Simultaneous multi-element determination of C, P, Hg, Br, Cl, S and F is achieved with the spectrometer based on a half meter radius concave holographic grating (1180 lines/mm) in a Rowland mounting. The plasma is viewed axially from the open end of the quartz discharge tube. The spectral range from 190 to 800 nm is covered in the first order. Wavelength modulation for background correction is achieved by means of a chopper disc and dual entrance slit. An inert "valveless" GC to cavity interface permits venting of the solvent while passing subsequent GC effluent to the cavity. A gas control unit contains the elements necessary to control the gas flow through the interface (including scavenger gas) as well as electronics to control the transfer line temperature. The interface is capable of supporting both packed column and capillary column chromatography.

Measurements of emission intensity across the diameter of the discharge tube indicated that maximum emission intensity for all elements occurred near the central axis of he tube and this position was independent of plasma power and plasma support gas flow rates. Optimized operating conditions resulted in detection limits of between 1 and 30 pg sec^{-1} for the elements studied. Attempts to eliminate background levels of nitrogen and oxygen through special gas purification steps and modification to the discharge tube were only partially successful.

The microwave emission plasma detector has successfully demonstrated the capability to be used as a fast screening technique for assessing compounds at trace levels in complex matrices. The intent of this study is to develop a rapid screening technique for target chemical species found in hazardous waste samples without an expensive and time-consuming sample clean-up prior to analysis. Only after this initial screening stage would more costly, high resolution (e.g. GC/MS or GC/ECD) analytical procedures/instrumentation be employed for samples with positive response to target chemical species.

ABSTRACT FORM

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Project No. : 103 PL Liaison Officer: D. Rokosh Phone: 235-5787

KEY WORDS : Mutagenicity, Ames Test, Groundwater, Landfill, Leachate, Bioassay.

Title: Development of Methods Suitable for Use in the Ames *Salmonella* Mutagenicity Assay for the Collection of Organics Present in Groundwater and Landfill Site Matrix Materials.

Abstract:

The objective of the study is to develop methods based on the Ames *Salmonella* mutagenicity assay to detect potentially harmful contamination of groundwater supplies by genotoxic substances leached from landfill sites. An initial literature review was performed to collect and define existing data available on contaminated groundwater/surface water associated with sanitary landfill and/or hazardous waste disposal operations. From this information a select list of chemicals (including suspected/known mutagens) was compiled which exhibit different functional group features as well as representing a wide range of chemical and physical properties. These chemicals are being used to develop and validate methods for the collection of organic concentrates from both groundwater and site matrix materials in order to provide material suitable for use in the Ames bioassay. The concentration methods are based on accumulator columns (resin adsorption), purging and solvent extraction techniques to determine the range of compounds that can be collected and establish their recovery limits. The organic compounds in the core matrix material (spiked) are being evaluated in terms of their leachability (aqueous, organic and total) compared to the total organic material in the core.

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KEY WORDS : PAH, Synthesis, Analytical Standards.

Title: Synthesis of Oxygen and Sulphur Polynuclear Aromatic Hydrocarbons of Interest in Environmental Pollution

Abstract:

Two novel approaches towards the synthesis of furan and thiophene annelated polynuclear aromatic hydrocarbons (PAHs') have been developed. One of these involve the use of cyclobutanones derived from thionyl ketone additions to olefins or aryl ketone additions to dihydrothiophenes or dihydrofurans. These cyclobutanones are subjected to selective ring opening and cyclization reactions by acid or base to give polycyclic ketones which are modified to the PAHs'. The second approach is the dehydration of thioformidyl aryl methanols under acidic conditions to give terminal PAH thiophenes. Details of both of these approaches will be discussed.

ABSTRACT FORM

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Project No. : 223 PL Liaison Officer: G. Crawford Phone: 235-5757

KEY WORDS : Automation, Robotics, Sample Preparation, Digestion, Extraction, Analysis-Biomaterials.

Title: Development of a Robotic Workstation for the Routine Analysis of Organics in Biological Tissues using Acid Digestion and Solvent Extraction Method.

Abstract:

In recent years, laboratory robotic systems have been recognized as a cost-effective means of automating sample processing and reducing human exposure to hazardous chemicals. Automation of sample preparation procedures have also, in general, improved the reliability of the analytical methods and provided higher quality data.

In this work, a Zymate Laboratory Robotic System has been used to develop a workstation for automated processing of fish tissue using an acid digestion and extraction method. Some of the main considerations addressed in this development include the following:

i) Maximization of sample throughput
ii) Comparison of accuracy and precision data using the manual and the automated procedures.
iii) User/operator safety and ease of use.
iv) Flexibility for modification of the developed program along with room for expansion.

In our implementation of the extraction procedures, all sample preparation steps are performed by the robot in modules. Such operations include weighing, dispensing, acid digestion, extraction, centrifugation, dilution, drying, neutralization and calculation.

An IBM compatible personal computer will be interfaced to the robot and its controller for sample input, data, calculation and sample management. Software will be developed to allow the operator greater control of the automated operation, and permit more sophisticated data processing then with only the Zymate Controller. This software will also provide an attractive menu-driven system for sample information, as well as capability for communication with other computers. More in-depth error checking and error recovery routines will also be investigated.

ABSTRACT FORM

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Project No. : 129 RR Liaison Officer: G. Wong Phone: 965-5776

KEY WORDS : Analysis-Air, Organics, Extraction, Chromatography, GC-MS.

Title: Separation and Identification of Organic Compounds in Extracts of Air Particulates by HPLC and GC/MS.

Abstract:

The organic compounds in extracts of air particulate were separated into acidic, basic, and neutral fractions by solvent extraction. The neutral fraction consisted of a large number of aliphatic and aromatic compounds. The identification of aromatic compounds that co-eluted with other compounds was very difficult by gas chromatography alone. Semi-preparative high pressure liquid chromatography (HPLC) was used to separate aliphatic compounds into one fraction and the aromatic compounds in several subsequent fractions. The retention behaviour of aromatic compounds on normal phase columns in HPLC was found to be typical, where capacity factors increased with an increase in the number of rings and was not largely affected by the alkyl substitution or the position of alkyl substitution on a particular aromatic compound. High resolution gas chromatography and mass spectrometry (GC-MS) were used for compound identification. The advantages of acid-base extraction and high pressure liquid chromatography prior to GC-MS analysis are discussed in detail.

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KEY WORDS : PAH, Analysis, Shpol'skii Spectroscopy.

Title: Quantitative Determination of Selected PAH's by Shpol'skii and Jet-cooled Spectroscopy.

Abstract:

Shpol'skii Spectroscopy has been demonstrated to be a highly selective and sensitive technique in the detection and identification of polynuclear aromatic hydrocarbons (PAH's) in the environment. In this technique a highly dilute solution of the sample in a solvent, such as n-octane, is added to a cell and cooled to a temperature of about 12K. The frozen matrix is illuminated with a laser and the resulting fluorescence is observed with a photomultiplier-monochromator combination. Two types of spectra are obtainable - a fluorescence spectrum in which the sample is illuminated at a fixed laser frequency whilst the fluorescence is scanned with a monochromator, and an excitation spectrum in which the fluorescence is observed in a fixed wavelength interval whilst the excitation frequency provided by a turntable laser is scanned. This technique can be easily adapted to quantitative analysis, because the peak heights of the quasi-lines generated by the Shpol'skii spectroscopic technique are proportional to the concentration of a given PAH provided that the signal does not saturate the photomultiplier and the laser intensity is not so high as to cause significant depletions of the ground state population. An additional requirement is that the concentrations used be low enough to minimize solute-solute interactions. Once a suitable quasi-line is selected, it is possible to obtain a calibration curve relating to the peak height normalized by the laser energy to the concentration of the PAH in a prepared solution in n-octane.

A complementary technique is that of Jet-cooled Spectroscopy. Here the sample is heated in an oven to generate a usable vapour pressure of the PAH. This vapour is subsequently mixed with helium or argon and the mixture is expanded into a chamber maintained at a low pressure by fast pumping. The gaseous mixture enters this chamber in the form of a free or over-expanded jet that is cooled by the strong adiabatic expansion to cryogenci temperatures. For example, 50 or so nozzle diameters downstream of the nozzle a rotational temperature of approximately 5-7K is obtained. At such low temperatures only the lowest rotational levels of the lowest vibronic state are significantly populated, and the absorption spectrum is thereby greatly simplified. Excitation spectra obtained by this technique resemble those obtained by Shpol'skii spectroscopy, but are shifted relative to the other in wavelength. This shift arises from the fact that in a matrix there are strong interactions between the PAH and the solvent molecules, whereas in a molecular jet beam the PAH molecules are virtually isolated. The proportionality between peak height and beam density under the same restrictions as discussed above permits the quantitative determination of PAH's. In this paper Jet-cooled spectra of selected PAH's will be presented as well as a progress report on the quantification of the beam technique.

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Project No. : 208 RR Liaison Officer: D. Hall Phone: 235-5910

KEY WORDS : PAH, Synthesis, Analytical Standards.

Title: New Synthetic Methodology for the Expedient Provision of Isomerically Pure PAH Analytical Standards.

Abstract:

Recent work in our laboratories has been focused on the application of the directed ortho metalation reaction **Scheme 1)** for the synthesis of a variety of PAHs and aza-PAHs of environmental interest. The increasing need for rapid and efficient access to diverse PAHs for analytical standards and for carcinogenesis research provides the impetus for the continuation of our efforts in this area. Extension of the aromatic directed metalation strategy to the synthesis of previously inaccessible halo- and methyl-PAHs by using silicon protection tactics will be described.

Accumulating evidence that the highly mutagenic nitro-PAHs are widely distributed in the environment has stimulated the application of methods discovered recently in our laboratories towards their synthesis. New syntheses of silylated PAHs **(Scheme 2)** and nitro-biphenyls **(Scheme 3)** will be presented and the evaluation of these compounds as precursors to nitro-PAHs will be reported.

ABSTRACT FORM

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Project No. : 148 PL Liaison Officer: E. Pastorek Phone: 235-5855

KEY WORDS : Multielement Analysis, Neutron Activation Analysis, ICP-US, Metols, Speciation, Intercomparison.

Title: A Critical Comparison of ICP-MS, INAA and GFAAS
for the Analysis of Snow and Water Samples

Abstract:

The major effort on ICP/MS has been the study of the isotope dilution and rhodium internal standard methods of concentration determination. The elements most intensively investigated were Ca, Sr, Nd and Pb. Calcium is the most difficult because of molecular species interference in this mass range. We are looking at several enriched spikes including ^{43}Ca, ^{44}Ca and ^{48}Ca. For Pb, we obtained the best results using Rh as an internal standard (at 1 ug/g concentration). Analyses of NBS 1643b water gives an average value of 22.6 ng/g (recommended value is 23.7 ng/g). Lead analyses on snow gives values in the range of 2.3-122 ppb. Isotopic ratio measurements of Pb are reproducable at ± 0.5% and will be presented.

Our efforts in Neutron activation analysis in the last two years have been two-fold. Firstly, we have concentrated on identifying the short-lived nuclides in both precipitation and lake water.

As an assurance for quality control, we have continuously analyzed a standard certified reference material (NBS trace elements in water, 1643b).

Secondly we have analyzed lake samples provided by MOE, Dorset. In particular, total aluminum concentrations were correlated in pH values. As expected, a strong negative correlation was obtained.

We also have participated in an aluminum round-robin analysis with MOE-Dorset, INRS-Quebec, J.R. Kramer-McMaster University and others. The results from Neutron Activation agreed very well.

Methods of analysis for arsenic were developed and critically compared to samples already analyzed by OME, by GFAAS. Results indicated that OME results were somewhat lower than those obtained by INAA suggesting volatilization of arsenic. Analysis of speciated aluminum was also compared to graphite furnace, ICP and other techniques. Results indicated that matrix effects were present in the analysis of aluminum by graphite furnace due to the presence of high dissolved organic carbon.

ABSTRACT FORM

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Project No. : 85 RR Liaison Officer: O. Meresz Phone: 235-5762

KEY WORDS : NMR, Analysis.

Title: Evalaution and Application of Pulsed Nuclear Magnetic Resonance in the Analysis of Environmental Samples

Abstract:

Nuclear magnetic resonance (NMR) has, for many years, been an important instrument in the qualitative analysis of molecular systems. The development of high magnetic field strengths along with pulse Fourier transform methodology has dramatically improved the resolution and sensitivity thereby widening the application of the NMR technique to weakly magnetic nuclei and to nuclei in low concentration.

More recently, however, low resolution NMR has been used in quantitative analysis. Pulsed low resolution NMR has, for example, been applied to the rapid, non-destructive determination of oil in oilseeds without the need to weigh and oven dry the seeds.

In this study, the Bruker PC 20 pulsed NMR as used to determine the moisture content and organic content of soils with a view to developing procedures for its use in the analysis of environmental samples. This is done by measuring the free induction decay (FID) signal of solid and liquid in soil samples. Analysis takes only minutes and the results obtained by this technique compare favourably with results obtained by other traditional analytical methods. Correlation values are routinely 0.993 and better.

Along with specific results to illustrate the advantages of this technique discussion will include the experimental effects of sample temperature, sample size, and calibration of the instrument. The methodology of the analysis will be presented along with its applications and limitations to environmental soil samples.

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Project No. : 270 RR Liaison Officer: D. Boomer Phone: 235-5858

KEY WORDS : ICP-US, Multielement Analysis, Sample Introduction Spectrometry.

Title: Performance of the Wire Loop Direct Sample Insertion Device for Atomic Emission and Mass Spectrometry with the Inductively Coupled Plasma

Abstract:

The wire loop direct sample insertion device has demonstrated detection limits which are 10 to 100 times better than obtained with nebulization sample introduction for both ICP-AES and ICP-MS. The detection limits can be further reduced by at least an order of magnitude using multi-drop insertion technique. The sample introduction technique has demonstrated remarkable precision over short and intermediate time spans (30 min and 3 hours). Precision better than 1% RSD is possible using a simple automated sample support has a small but significant effect on the signal. Theoretical and practical considerations for multi-element work will be discussed for ICP-AES and for ICP-MS with attention to the limitations imposed by the SCIEX Elan instrument design.

SECTION E

ENVIRONMENTAL ECONOMICS

ABSTRACT FORM

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Project No. : Internal Project PPB, Liaison Officer: J. Donnan Phone: 323-4579

KEY WORDS : Abatement Cost, Economic Evaluation, Environmental Economics.

Title: "Abatement Cost Functions - The Workhorse of Environmental Management"

Abstract:

Abatement cost functions are tables or algebraic statements which relate varying levels of pollutant treatment or reduction to the costs (in monetary terms) of achieving them. Abatement cost functions may be developed for a wide variety of control technologies, production processes, industrial establishments or for specific pollutants or contaminants. Abatement cost functions have been extremely useful tools for:

1. assessing the costs and financial impacts of achieving specific emission objectives,
2. determining the implications of different enforcement policies,
3. predicting a firm's reaction to particular environmental objectives,
4. developing cost-effective abatement programs,
5. conducting benefit-cost analyses,
6. evaluating abatement programs after they have been implemented.

Methods for developing abatement cost functions will be critically reviewed. A computer program called the Waste Treatment Analysis Program (WATAP), developed by the Ministry to generate abatement cost estimates, will be highlighted.

Examples of how abatement cost functions have been derived and applied in specific cases will then be presented. These case studies include nickel smelters, lime plants, and electric power plants in Ontario.

ABSTRACT FORM

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Project No. : 265 PL Liaison Officer: S. Glover Phone: 323-4578

KEY WORDS : Biotechnology, Recombinant DNA, Cell Fusion.

Title: Biotechnology Policy Development

Abstract:

The study has two main objectives. First, to identify activities and organizations in Canada which are involved in the development and/or application of biotechnological activities, particularly the alteration of organisms by recombinant DNA techniques, and second, to determine policy issues and approaches for the development of policies concerning the regulation of biotechnology activities.

By means of literature reviews and interviews, relevant biotechnology activities in Canada will be identified (especially recombinant DNA work), environmental effects will be postulated, and policy issues and approaches will be determined. Two seminars will be held to obtain a tentative consensus and, possibly, a priority listing about environmental effects and policy issues.

Study findings will provide a foundation for development of policies to regulate and ensure the safety of biotechnology activities, primarily those related to recombinant DNA techniques.

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KEY WORDS : Waste Management, Transport of Waste, Liquid Industrial Waste.

Title: A Study on the Structure of the Liquid Waste Management (Transportation) Sector in Ontario.

Abstract:

The disposal of liquid wastes is a complex and contentious business and has received considerable attention. A large proportion of these wastes is disposed of or stored at the location where it is generated. However, substantial volumes are also disposed "off site". This fact leads to the consideration of the private sector costs associated with the transportation of the wastes, and special handling and treatment requirements for each type of pollutant.

This paper will address key issues concerning the nature and the market structure of the liquid waste transportation industry. Interviews will be conducted with generators of liquid industrial waste, and with operators of various sizes, in various locations, who haul the wastes.

This study should fill an important information gap concerning the performance characteristics of large and small operators in the liquid waste transport industry, especially within the context of the existing and proposed regulatory requirements of the Ontario and Federal Governments.

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